

AD-A070 691 BAKER (MICHAEL) JR INC BEAVER PA

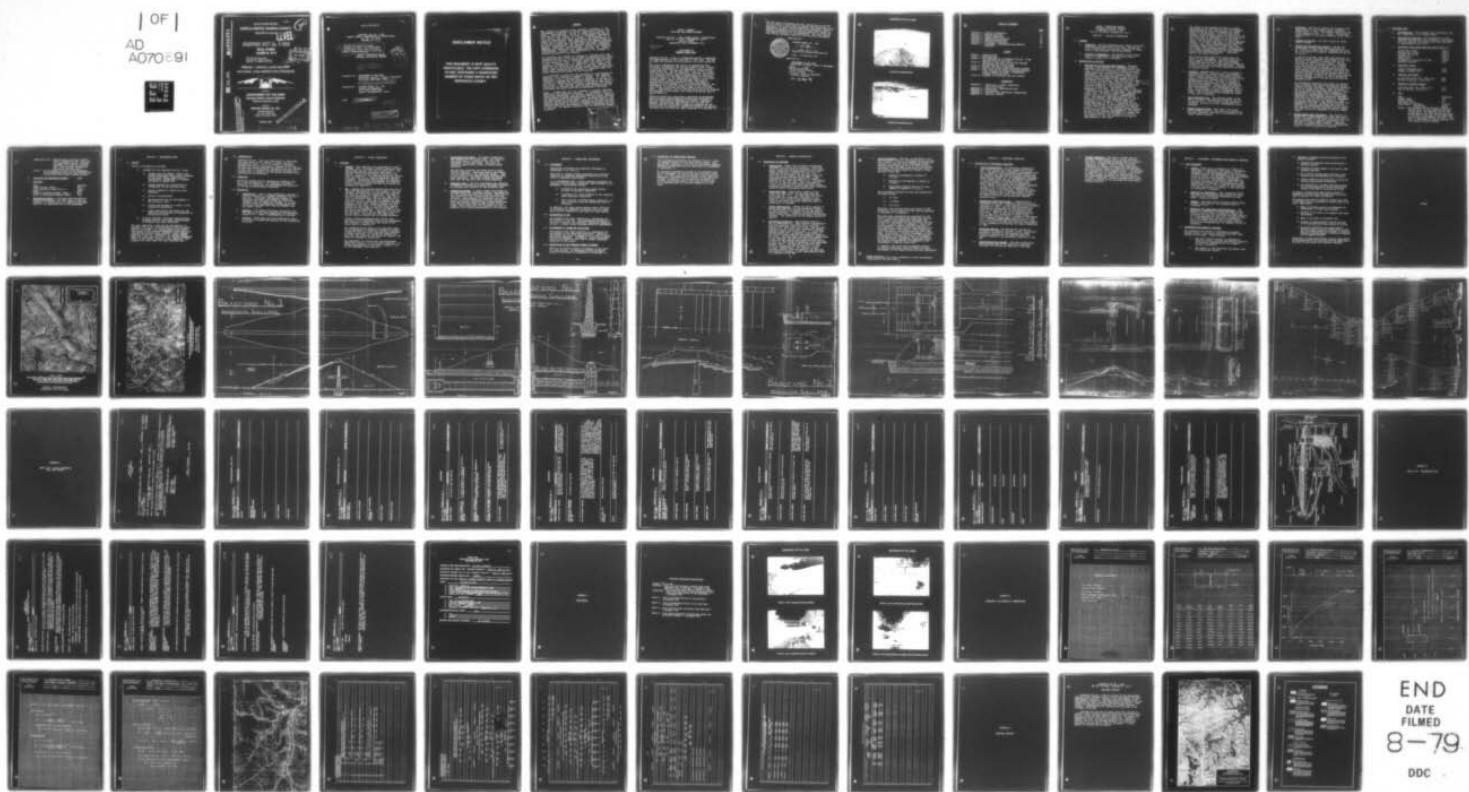
NATIONAL DAM INSPECTION PROGRAM. BRADFORD CITY NUMBER 3 DAM (ND--ETC(U)
FEB 79 C Y CHEN

F/G 13/2
DACP31-79-C-0011

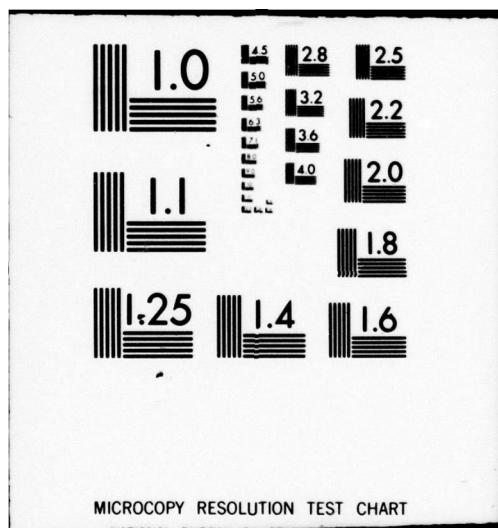
NL

UNCLASSIFIED

| OF |
AD
A070 691



END
DATE
FILED
8-79
DDC



DA070691

DDC FILE COPY

OHIO RIVER BASIN
MARILLA BROOK, McKEAN COUNTY
PENNSYLVANIA

LEVEL II

BRADFORD CITY No. 3 DAM

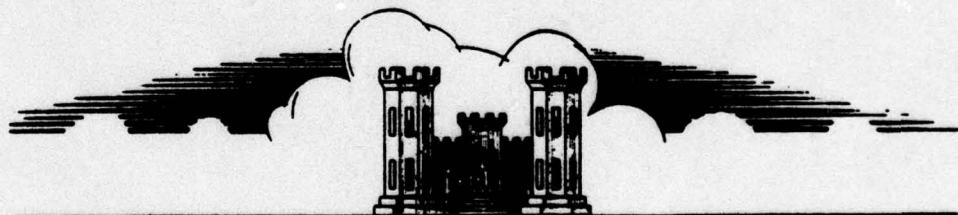
NDI No. PA 00025

PennDER No. 42-10

Distribution Unlimited
Approved for Public Release
Contract No. DACW31-79-C-0011



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



prepared for

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

prepared by

MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

THIS DOCUMENT IS BEST QUALITY FRACTICOLOR.
THE COPY FURNISHED TO DDC CONTAINED A
SIGNIFICANT NUMBER OF PAGES WHICH DO NOT
REPRODUCE LEGIBLY.

ORIGINAL CONTAINS COLOR PLATES: ALL DDC
REPRODUCTIONS WILL BE IN BLACK AND WHITE.

February 1979

410 795

79 06 28 073

OHIO RIVER BASIN

BRADFORD CITY NO. 3 DAM
McKEAN COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI NO. PA 00025
PennDER NO. 42-10

6
National Dam Inspection Program.
Bradford City Number 3 Dam (NDI-PA-00025,
PennDER Number 42-10), Ohio River Basin,
Marilla Brook, McKean County, Pennsylvania.
Phase I Inspection Report

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



10 C.Y. Chen

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

15 DADW31-79-C-0011

Prepared by: MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

Date:

11 February 1979

12 80p

This document has been approved
for public release and sale; its
distribution is unlimited.

410 795 79 06 28 073

JOB

DISCLAIMER NOTICE

**THIS DOCUMENT IS BEST QUALITY
PRACTICABLE. THE COPY FURNISHED
TO DDC CONTAINED A SIGNIFICANT
NUMBER OF PAGES WHICH DO NOT
REPRODUCE LEGIBLY.**

PREFACE

This report is prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

REASON FOR INSPECTION	GENERAL WATER LEVEL TYPICAL INCORPORATED IN STRUCTURE	UNANNOUNCED INVESTIGATION	JUSTIFICATION	BY	DISCUSSION OR INTERVIEW WITH OWNER AND/OR OPERATOR	APPROPRIATE CODES AND/OR STANDARDS AND/OR SPECIAL REGULATIONS
23 DRAFT						

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Bradford City No. 3 Dam, McKean County, Pennsylvania
NDI No. PA 00025, PennDER No. 42-10
Marilla Brook
Inspected 8 and 9 November 1978

[CONT'D FROM
P. 1]

ASSESSMENT OF
GENERAL CONDITIONS

Bradford City No. 3 Dam is a diaphragm earthfill embankment dam approximately 47 feet high and 770 feet long. The dam is owned and operated by the Bradford City Water Authority.

The visual inspections and review of engineering data, performed in November 1978 through February 1979, indicate no serious deficiencies in the embankment requiring emergency attention. The dam was found to be in good overall condition at the time of inspection. However, the inspection revealed certain items of maintenance and rehabilitation necessary for the dam, including repair of the animal burrows, removal of the vegetation and debris in the downstream channel, repair of the upstream slope riprap, repointing of spillway structure joints, placement of adequate erosion protection in the downstream channel, and development of a plan for rapid closure of the upstream ends of the outlet pipe and water supply pipe in an emergency. Additionally, the two seepage areas should be examined periodically in the future, and a record should be kept of their condition.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District of the U.S. Army Corps of Engineers for Phase I Inspection Reports, revealed that the spillway will not pass the Probable Maximum Flood (PMF) without overtopping the dam. The spillway is considered "inadequate" because the analysis indicated the spillway will pass a maximum of 45 percent of -----.

the PMF before overtopping the dam, and failure of the dam is not likely to occur under 50 percent PMF conditions. Therefore, the owner should immediately undertake a detailed engineering study to evaluate the spillway capacity and to develop recommendations for remedial measures to reduce the overtopping potential of the embankment. The owner should also develop emergency operation and evacuation procedures.

Submitted by:



MICHAEL BAKER, JR., INC.

C. Y. Chen

C. Y. Chen, Ph.D., P.E.
Engineering Manager-Geotechnical

Date: 16 February 1979

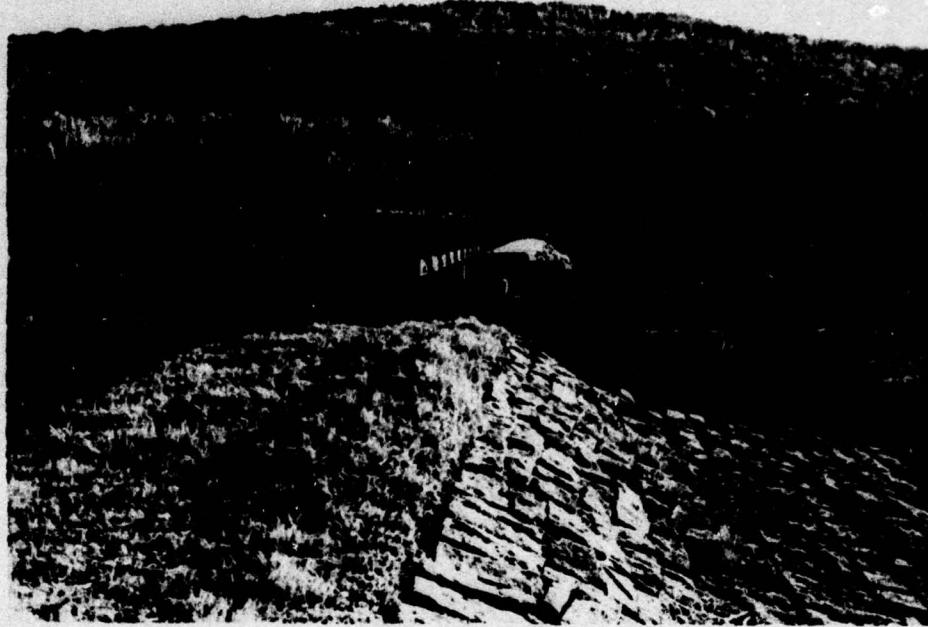
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. Withers
G. K. Withers
Colonel, Corps of Engineers
District Engineer

Date: 15 Mar 79

BRADFORD CITY No. 3 DAM



Overall View of Upstream Area



Overall View of Downstream Area

TABLE OF CONTENTS

	<u>Page</u>
Section 1 - Project Information	1
Section 2 - Engineering Data	6
Section 3 - Visual Inspection	8
Section 4 - Operational Procedures	10
Section 5 - Hydraulic/Hydrologic	12
Section 6 - Structural Stability	14
Section 7 - Assessment, Recommendations/Remedial Measures	16

PLATES

- Plate 1 - Location Plan
- Plate 2 - Watershed Map
- Plate 3 - Plan and Section of Bradford City No. 3 Dam and Elevation of Core Wall
- Plate 4 - Details of Core Wall and Section Through Dam Showing the Outlet Pipes
- Plate 5 - Section and Plan of Spillway
- Plate 6 - Details of Outlet Pipes and Screen Chamber
- Plate 7 - Plan, Profile and Section Showing Proposed (1916) Changes in Height of Embankment (Changes Performed 1923)
- Plate 8 - Original Soil Borings and Soil Profile

APPENDICES

- Appendix A - Check List - Visual Inspection and Field Sketch
- Appendix B - Check List - Engineering Data
- Appendix C - Photographs
- Appendix D - Hydraulic and Hydrologic Computations
- Appendix E - Regional Geology

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BRADFORD CITY NO. 3 DAM
NDI NO. PA 00025, PennDER No. 42-10

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority - The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.
- b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances - Bradford City No. 3 Dam consists of a diaphragm earthfill embankment approximately 47 feet high and 770 feet long. A core wall consisting of mortar and sandstone blocks was constructed in the center of the embankment. The core wall extends 25 feet into each hillside and approximately 9 feet below the original ground surface at the deepest point in the center of the valley. The core wall is 2 feet wide at the top and 6 feet wide at the base. The core wall rests on an 18-inch thick, 8-foot wide, concrete foundation. The concrete foundation rests on in situ soil. The crest width of the embankment is 12 feet, and the core wall is located 7 feet below the center of the crest. The upstream slope to El. 1728 feet is paved with sandstone blocks laid on a 12-inch thick, crushed stone base. The remaining upstream slope to the toe is paved with cobbles. The upstream slope is 2.5 horizontal to 1 vertical (2.5H:1V) while the downstream slope is 2H:1V. A trapezoid (at the widest dam section), 56 feet wide at the base and 12 feet wide at the crest constructed of "select material," is shown on the original design drawings as the central zone of the embankment. The outer portion of the upstream embankment is another zone of "select material" and is shown as a 20-foot wide section at the toe tapering to the apex at approximate El. 1735 feet.

↓
[CONT'D
ON P. ii]

The center of the ungated spillway is located approximately 90 feet right of the left abutment. Sandstone blocks form the abutments (training walls) of the spillway. A 3-foot wide, steel walkway located directly above and parallel to the spillway crest is supported by a 1-foot wide by 3-foot long pier at the center of the spillway crest. The spillway consists of a 12H:1V approach channel, a 3.5-foot long crest (in the direction of flow), and a 5H:1V sandstone-block-lined, discharge channel which is 33 feet long. From this point, the discharge channel is stepped down to a timber planking overflow into the concrete-rubble-lined downstream channel. Additional details are shown on Plate 7.

Two 16-inch outlet pipes are located near the center of the embankment. One pipe serves as a water supply line and the other is outletted downstream from the dam. The intake structure is located at the toe of the upstream slope. Details of the outlet pipes and intake structure are shown on Plates 4 and 6.

- b. Location - Bradford City No. 3 Dam is located in Bradford Township, McKean County, Pennsylvania approximately 5 miles west of Bradford, Pennsylvania. Located adjacent to the north shore of the reservoir and left abutment area of the dam is Pennsylvania Route 346. The dam is located on Marilla Brook approximately 5 miles upstream of the City of Bradford. Gilbert Run joins Marilla Brook approximately 1 mile downstream from the dam. An additional 2.5 miles downstream, Marilla Brook joins the West Branch of Tunungwant (Tuna) Creek. Tuna Creek then flows through the center of the City of Bradford.
- c. Size Classification - The maximum height of the dam is 47 feet. The reservoir volume to the top of the dam at El. 1750.8 feet is 502 acre-feet. Therefore, the dam is in the "Intermediate" size category.
- d. Hazard Classification - More than a few lives would likely be lost in the event of a failure of the dam; therefore, this dam is considered in the "High" hazard category.

- e. Ownership - The dam is owned by the Bradford City Water Authority, 24 Kennedy Street, Bradford, Pennsylvania 16701. The present chairman of the water authority is Mr. O. C. Knott. The present superintendent of the water authority is Mr. Pat A. Nuzzo.
- f. Purpose of the Dam - The dam is used for water supply storage.
- g. Design and Construction History - The dam was constructed in 1898 under the supervision of Mr. Charles A. Hague, who also prepared the plans. Mr. W. M. Hanley of Bradford, Pennsylvania was the contractor.

A record of borings, made under the direction of Elbert Nostrand, Engineer and Surveyor of New York, New York, was prepared in August 1898 and is presented as Plate 8 of this report. Thirteen (13) borings were performed on 50-foot centers along the centerline of the dam, with an additional three borings performed approximately 400 feet upstream from the centerline. No record was readily available relating the assumed datum for the soil borings to the datum used for the original design drawings. However, it can be determined that the foundation of the dam and core wall was founded on soil.

No information concerning the method of construction or changes from the design drawings during construction was available. Information contained in the 11 August 1915 "Report Upon the Number 3 Dam of the Bradford Municipal Water Works," which was prepared by the Water Supply Commission of Pennsylvania [predecessor to the Pennsylvania Department of Environmental Resources (PennDER)], indicates that the borrow area for the embankment was at the upper end of the reservoir. Other information contained in the report describes the embankment, core wall, spillway, and outlets. However, the descriptions contained in the report were apparently derived from the original design drawings and may not represent "as built" conditions.

- h. Normal Operational Procedures - The reservoir is maintained at approximately the same level year round. Personnel of the water authority visit the gate house daily to regulate and maintain the chlorine for water supply purposes. Typically, the dam is examined twice a week to determine the extent of routine maintenance required.

1.3 PERTINENT DATA

Impervious Core - Masonry-stone core wall consisting of sandstone blocks laid with portland cement mortar. Maximum thickness is 6 feet at the base and 2 feet minimum thickness at the top of the core wall.

Cutoff - At the deepest section of the embankment the stone-masonry core wall was constructed 9 feet below the original ground surface.

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type -	Overflow
Width of Weir (feet) -	58.6
Crest Elevation (feet M.S.L.) -	1744.0
Gates -	None
Width of Upstream Channel (feet) -	59.3
Width of Downstream Channel (feet) -	59.8

j. Regulating Outlets - A 16-inch cast-iron pipe is located approximately 350 feet right of the left abutment. A control valve is located in the gate house of the downstream toe of the embankment.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Review of information included:

- 1) PennDER file for Bradford City No. 3 Dam:
 - a) "Report Upon the Number 3 Dam of the Bradford Municipal Water Works" prepared by the Water Supply Commission of Pennsylvania (predecessor of PennDER) and dated 11 August 1915.
 - b) Design drawings for installation of flashboards on the spillway crest.
 - c) Various inspection reports by state personnel.
 - d) Various correspondence.
 - e) Specifications for the enlargement of the spillway (1923).
 - f) Various photographs as a result of the inspections performed.
 - g) Permit application and permit for the temporary installation of flashboards on the spillway crest.
- 2) Original drawings, with some modifications, obtained from Mr. Pat Nuzzo, Superintendent of Bradford City Water Authority.

The last inspection of the dam was performed on 15 September 1977 by Mr. Walter Leidig of the Dam Safety Section of PennDER. Mr. Leidig noted in his report, "The riprap on the upstream embankment slope should be reworked and missing stone replaced. Minor seepage observed at the toe. Vegetation is causing seepage under the right spillway wall." Mr. Leidig recommended repair of the riprap, removal of the vegetation, and plugging the leaks under the right spillway wall.

2.2 CONSTRUCTION

Bradford City No. 3 Dam was constructed in 1898 under the supervision of Mr. Charles A. Hague, who also prepared the plans. Mr. W. M. Hanley, of Bradford, Pennsylvania was the contractor. Because of the age of the dam and because detailed information was not recorded at that time, no information concerning the method of construction or changes from the design drawings during construction was available.

2.3 OPERATION

Operation records are not recorded for Bradford City No. 3 Dam and Reservoir. The Bradford City Water Authority is responsible for maintenance and operation of the dam and appurtenant structures.

2.4 EVALUATION

- a. Availability - Much of the information reviewed is readily available in PennDER's Bradford City No. 3 Dam file. Additional information helpful in assessing the safety and potential hazard was requested from the owner of the dam. It is very doubtful that any additional information exists concerning this dam other than in PennDER's and the owner's files.
- b. Adequacy - The readily available information and the results of the field inspection are considered adequate for a Phase I Investigation of the dam.
- c. Validity - Based upon the field observation there is no cause to doubt the validity of the information available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General - The inspection was performed on 8 and 9 November 1978. No unusual weather conditions were experienced and the lake was at normal pool. The dam and appurtenant structures were found, in general, to be in good overall condition at the time of inspection. The problems noted are considered minor and do not require immediate remedial treatment. Noteworthy deficiencies are described briefly in the following paragraphs. The complete visual inspection check list and field sketch are presented in Appendix A.
- b. Dam - Seepage was observed exiting from the toe of the slope approximately 575 feet right of the left abutment. No migration of fine materials (piping) was observed during the inspection. The area in plan was approximately 1 square foot. The rate of flow is considered minor and was estimated to be less than 1 g.p.d. This area of seepage has been noted in various inspections performed by PennDER personnel since 1922. Another seepage area was observed to the right of the gate house (approximately 350 feet right of the left abutment) at the toe of the embankment. This area did not have any discernible flow, but it appeared to be moist all the time. This area has also been noted during previous inspections by PennDER personnel.

Several rodent/groundhog/animal burrows were observed in the downstream slope of the embankment. The locations of these holes are shown on the field sketch in Appendix A.

The sandstone block riprap on the upstream slope of the embankment is missing at several locations (typically just one block) and should be replaced. At other locations, the riprap has "popped out" such that the riprap is not lying flat against the slope as originally constructed.

The embankment is covered with well-maintained grass and, overall, is in very good condition. No serious deficiencies in the crest, slopes or toe of the embankment were observed.

c. Appurtenant Structures - No unusual conditions were observed at the outlet pipe. The valve for the outlet pipe is located at the toe of the embankment in the gate house. The valve is typically opened twice a year to insure proper operation.

The spillway structure was found to be in good overall condition. Some minor debris and vegetation was observed in the discharge channel. Some of the joints in the masonry block training walls need repointing. The steel walkway and bridge pier over the spillway were in good condition.

d. Reservoir Area - The area surrounding the reservoir is gently to moderately sloping and highly forested. No problems were observed in the reservoir area.

e. Downstream Channel - A small access road bridge is located across the downstream channel, approximately 500 feet downstream from the spillway (see Photo 4). This bridge will not constrict the flow from the spillway. Approximately 30 residences are located in the first mile downstream from the reservoir. There are several hundred homes located downstream along Marilla Brook and the West Branch of Tuna Creek. Tuna Creek then flows through the City of Bradford (1970 census approximately 13,000 people).

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures are generally discussed in paragraphs 1.2.h. and 2.3.

There are no formal written procedures for reservoir operation or emergency downstream evacuation in the event of impending catastrophe.

It is recommended that a formal emergency procedure be prepared and prominently displayed, and furnished to all personnel. This should include:

- 1) Procedures for evaluating inflow during periods of emergency operation.
- 2) Procedures for rapid drawdown of the reservoir under emergency conditions.
- 3) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

In addition, the owner should assist public officials in developing an emergency evacuation plan for areas which will be affected in the event of a dam failure.

4.2 MAINTENANCE OF DAM

The Bradford City Water Authority is responsible for maintenance of the dam. The maintenance procedures of the water authority are generally considered adequate; however, a rodent control program should be implemented.

4.3 MAINTENANCE OF OPERATING FACILITIES

The Bradford City Water Authority is responsible for maintenance of the operating facilities. Typically, the outlet pipe valve is opened twice a year to insure operational adequacy. Presumably, proper maintenance would be performed at this time to insure continued operation in the future.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or procedure in the event of a dam failure. An emergency warning procedure should be developed as recommended in paragraph 4.1.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The maintenance procedures for Bradford City No. 3 Dam are adequate except for the deficiencies noted. The operational functions of the dam are considered adequate. Emergency procedures should be developed as recommended in paragraph 4.1.

No closure is presently provided on the upstream side of the embankment for the outlet pipe and water supply pipe. If either pipe should develop a leak within the embankment, the potential for failure of the dam would be high. Therefore, a plan should be developed for closing the upstream ends of the pipes in the event of an emergency and for periodic inspection of the pipes.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data - There were no design calculations available for review and evaluation. The first check of spillway capacity performed by the Water Supply Commission of Pennsylvania in 1915 indicated the spillway capacity was 1316 c.f.s. According to the report, the spillway would not pass the Probable Maximum Flood (PMF). They recommended revising the spillway to achieve a capacity of not less than 1700 c.f.s. The embankment top of dam was later (1923) increased by 3 feet, and the spillway wing walls were correspondingly increased to provide additional discharge capacity before overtopping would occur.
- b. Experience Data - Based upon a report of the 17-20 July 1942 flood, the spillway peak discharge was 640 c.f.s. No other data were available except for occasional references of the reservoir level noted on the inspection report forms of the Water and Power Resources Board (a predecessor of PennDER).
- c. Visual Observations - Except for minor amounts of debris and vegetation in the downstream channel, no deficiencies were observed in the spillway or spillway channels. Frequent routine maintenance should remove debris from the spillway and spillway channels. The vegetation in the channel should be removed.
- d. Overtopping Potential - The Bradford City No. 3 Dam is classified as a "High" hazard- "Intermediate" size dam requiring evaluation for a spillway design flood (SDF) equal to the PMF. The spillway consists of a 59.6-foot wide, rectangular shaped, approach channel and control weir. A 1-foot wide, walkway bridge pier is located at the center of the spillway crest reducing the effective width to 58.6 feet. The hydrologic and hydraulic capabilities of the reservoir and spillway were evaluated by routing the PMF through the reservoir with the aid of the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1. The PMF and 1/2 PMF were both found to overtop the dam by depths of 1.6 and 0.5 feet, respectively. The results of this analysis indicate that the reservoir and spillway are capable of passing a flood approximately equal to 45 percent of the PMF.

e. Spillway Adequacy - The dam, as outlined in the above analysis, would be overtopped by the 1/2 PMF. The criteria, for spillway adequacy determination, requires an estimate of the likelihood of dam failure during overtopping by 1/2 PMF conditions. Therefore, the following conditions were used as the limiting criteria which are likely to cause failure of this dam.

- 1) Depth of overtopping in excess of 1.0 foot.
- 2) Duration of overtopping in excess of 4 hours.*
- 3) Approximate maximum velocity of overtopping in excess of 4 f.p.s.*

The overtopping analysis of this dam yielded the following values.

- 1) 0.5 foot
- 2) 1.5 hours
- 3) 2.8 f.p.s.

Therefore, dam failure during the above 1/2 PMF conditions is not likely to occur and the spillway is assessed as "inadequate."

The hydrologic determinations presented in this Phase I Inspection Report are based upon the use of a Snyder's unit hydrograph developed from coefficients determined by the Baltimore District of the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed, a further refinement of these coefficients is beyond the scope of this Phase I investigation and, therefore, must be addressed by the dam owner's engineering consultant during the detailed investigation as suggested in the "Assessment of General Conditions."

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

*These parameters will vary according to cover and material conditions of the dam crest.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations - No structural inadequacies were noted during the visual inspection of the dam. The seepage areas indicated in paragraph 3.1.b. do not appear to have increased significantly from the descriptions provided by previous inspections performed by PennDER (or its predecessor) personnel. These seepage areas are not considered detrimental to the stability of the dam according to the conditions present at the time of inspection. These seepage areas should be periodically examined in the future to verify that the quantity of seepage is not increasing and transportation of fine material is not occurring. Should the extent of the seepage areas or characteristics of the seepage increase with time, the condition should be studied in detail and appropriate remedial measures taken.
- b. Design and Construction Data - Calculations of embankment slope and foundation stability were not available for review. Given the age of the structure (designed in 1898), and the state-of-the-art in geotechnical engineering and dam design at that time; it is expected that no calculations were performed. Based on the visual observations and also on empirical guidelines on stable slope inclinations given by the U.S. Bureau of Reclamation (1973) Design of Small Dams, 2nd edition, pp. 261-267; it is concluded that Bradford City No. 3 Dam could be shown to satisfy the stability requirements of the "Recommended Guidelines for Safety Inspection of Dams."
- c. Operating Records - No operational records are available for Bradford City No. 3 Dam. Operational procedures obtained by interviewing the water authority personnel do not indicate cause for concern related to the structural stability of the dam.
- d. Post-Construction Changes - The post-construction modifications made to the dam do not adversely influence the structural stability of the dam.

e.

Seismic Stability - The dam is located near the boundary between Zones 1 and 2 on the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." Both of these zones are considered to present no hazard from earthquakes provided static stability conditions are satisfied and conventional safety margins exist. As indicated in paragraph 6.1.b., Bradford City No. 3 Dam could be shown to meet the stability requirements of the "Recommended Guidelines for Safety Inspection of Dams." Therefore, further consideration of the seismic stability is not warranted for this Phase I Inspection Report.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

- a. Safety - There are no findings, as a result of this Phase I Inspection, from which a detrimental assessment of the structural stability can be rendered provided the embankment is not overtopped by flood waters. The spillway capacity was analyzed using the procedures presented in paragraphs 5.1.d. and 5.1.e. The analysis, based upon the routings, determined that the spillway will pass approximately 45 percent of the PMF before overtopping will occur. As a result of this observation and others noted in Section 5, the spillway is considered "inadequate."
- b. Adequacy of Information - The information available and the observations made during the field inspection are considered sufficient for this Phase I Inspection Report.
- c. Urgency - The owner should initiate without delay further investigation, as discussed below in paragraph 7.1.d.
- d. Necessity for Additional Data/Evaluation - The hydraulic/ hydrologic analysis performed in connection with this Phase I Inspection Report has indicated the need for additional spillway capacity. It is recommended that the owner of Bradford City No. 3 Dam immediately initiate an engineering study to further evaluate the spillway capacity and develop recommendations for remedial action as necessary.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection and review of information revealed certain items of work which should be performed immediately by the owner. These include:

- 1) The owner should initiate an engineering study to further evaluate the spillway capacity and develop recommendations for remedial action as necessary.
- 2) The removal of the vegetation and debris from the downstream channel.

- 3) Development of emergency operations procedures for the reservoir including:
 - a) Procedures for evaluating inflow during periods of emergency operation.
 - b) Procedures for rapid drawdown of the reservoir under emergency conditions.
 - c) Who to notify, including public officials, in case evacuation from the downstream area is necessary.
 - d) Provide around-the-clock surveillance of the dam and reservoir during periods of high runoff.
 - e) The installation of a reliable flood warning system for all areas downstream of the dam which would be affected in the event of the failure of the dam.

In addition, the owner should assist public officials in developing the evacuation plan for areas which will be inundated in the event of a flood or dam failure.

The inspection and review of information revealed other items of work which should be accomplished in the near future by the owner. These include:

- 1) Repair of the animal burrows in the embankment and establishment of a rodent control program.
- 2) Repointing of the joints of the sandstone block spillway structure.
- 3) Repair of the riprap on the upstream face.
- 4) Placement of riprap protection along the left bank of the downstream channel where erosion is occurring.
- 5) The periodic inspection of the seepage areas to identify a change in quantity or the exiting of muddy water from these areas and, if necessary, to assess the stability and piping potential of the dam in connection with the seepage conditions.

Additionally, the owner should develop a plan for rapid closure at the upstream ends of the outlet pipe and water supply pipe in the event of a pipe rupture and for periodic inspection.

PLATES

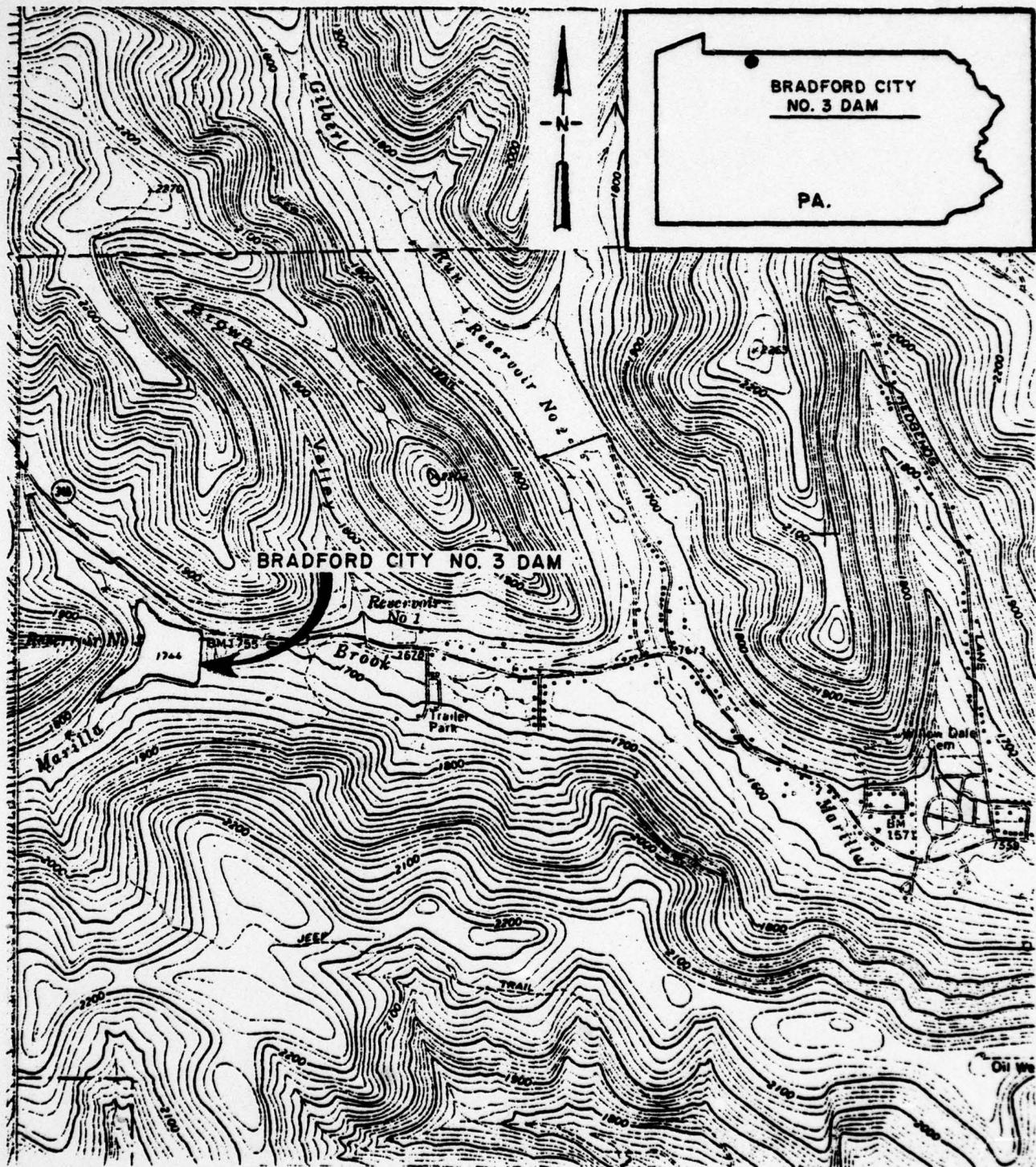


PLATE I LOCATION PLAN
BRADFORD CITY NO. 3 DAM

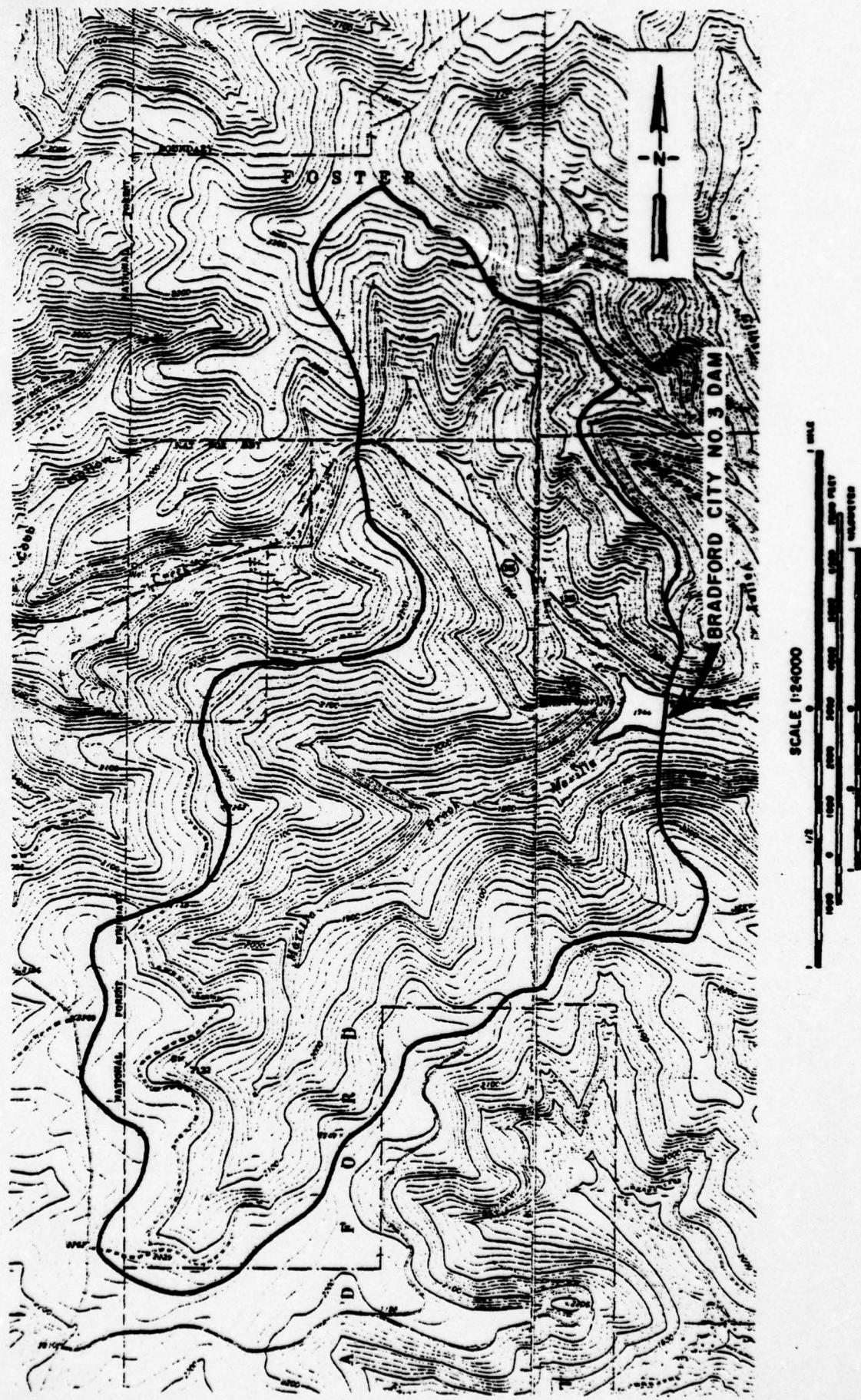
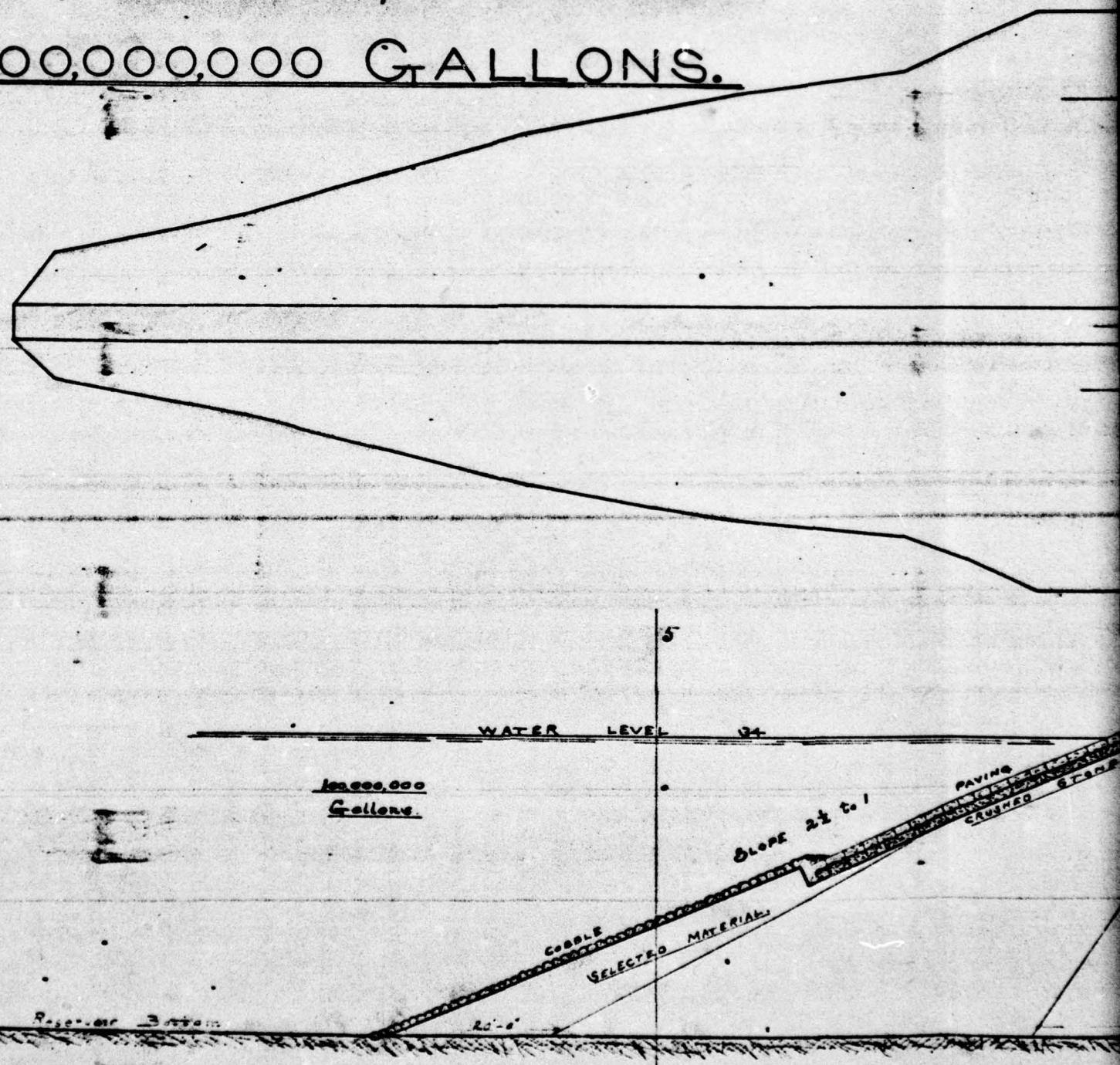


PLATE 2 WATERSHED MAP
BRADFORD CITY NO. 3 DAM

N ← O →

BRADFORD No. 3.

100,000,000 GALLONS.

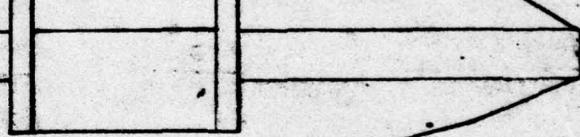


Chas. H. ... Aug 26 98

ELEVATION OF CORE WALL.

Scale 24' = 1'

PLAN OF DAM.



SECTION OF DAM.

Scale $\frac{1}{8} = 1'$

SELECTED MATERIAL

SELECTED MATERIAL

BRADF

100,000.0

DETAILS OF
OUTLET

Scale $\frac{1}{2}$ - 1

CONCRETE

5

35'-0"

55

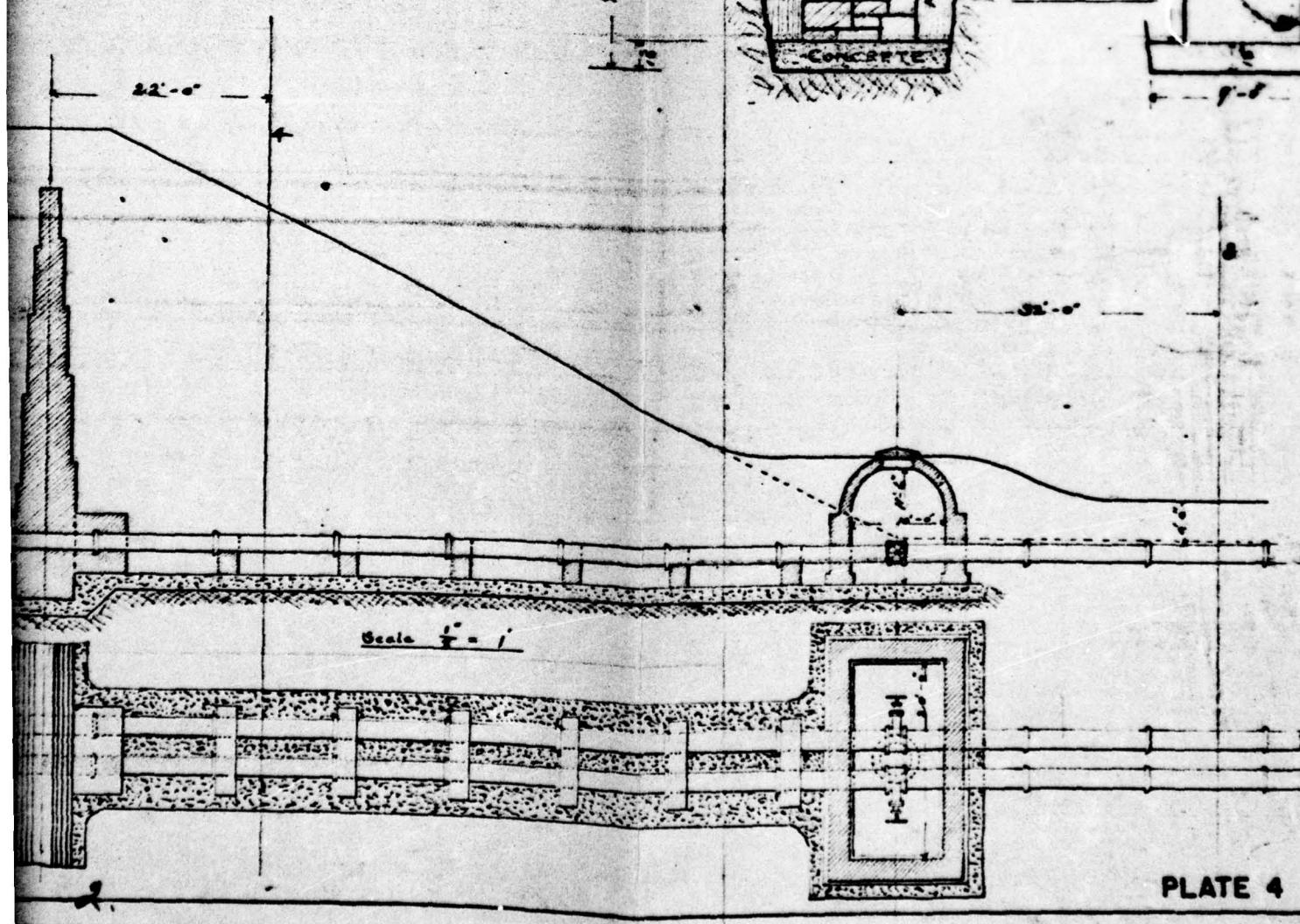
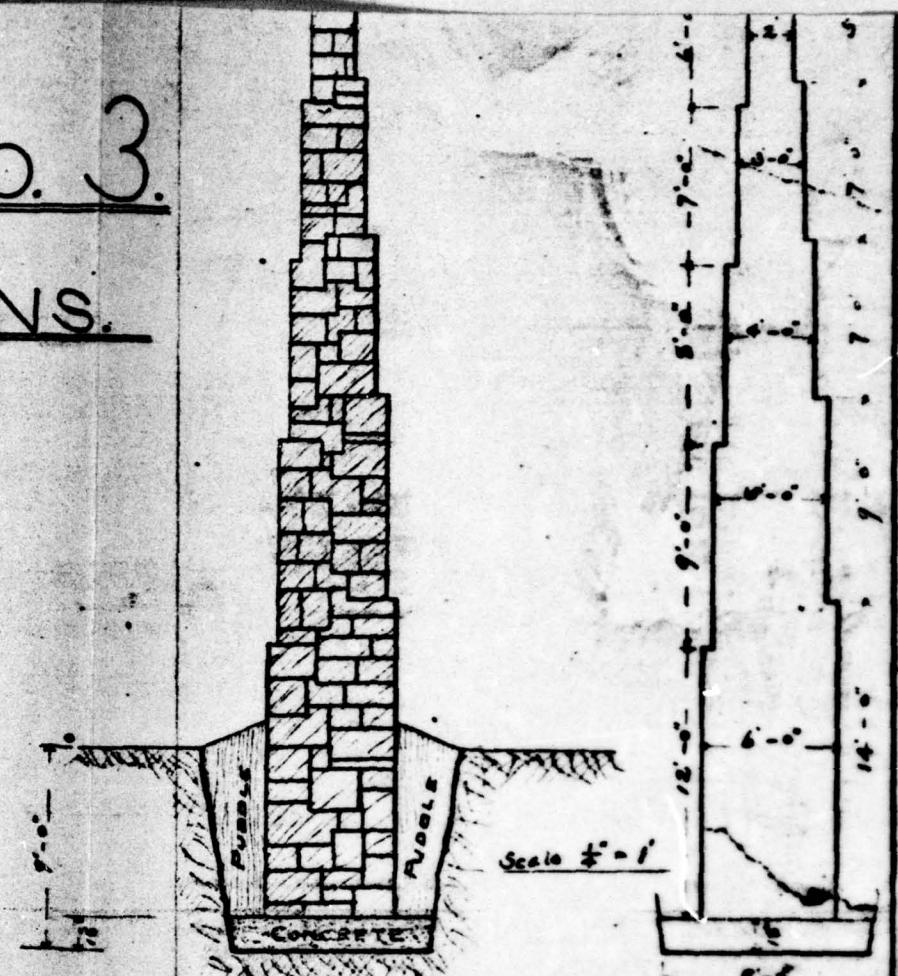
TWO 16" OUTLET PIPES.

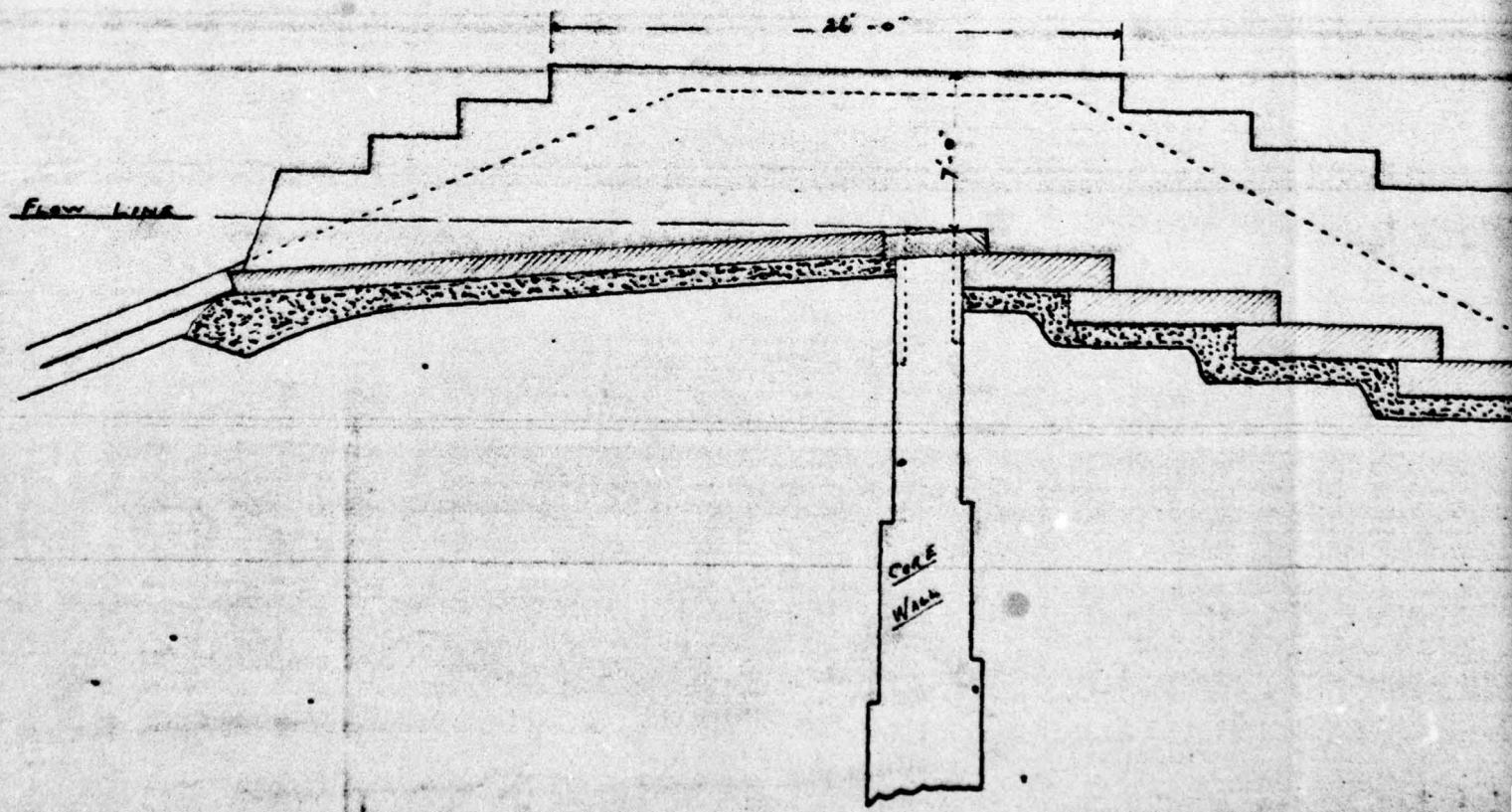
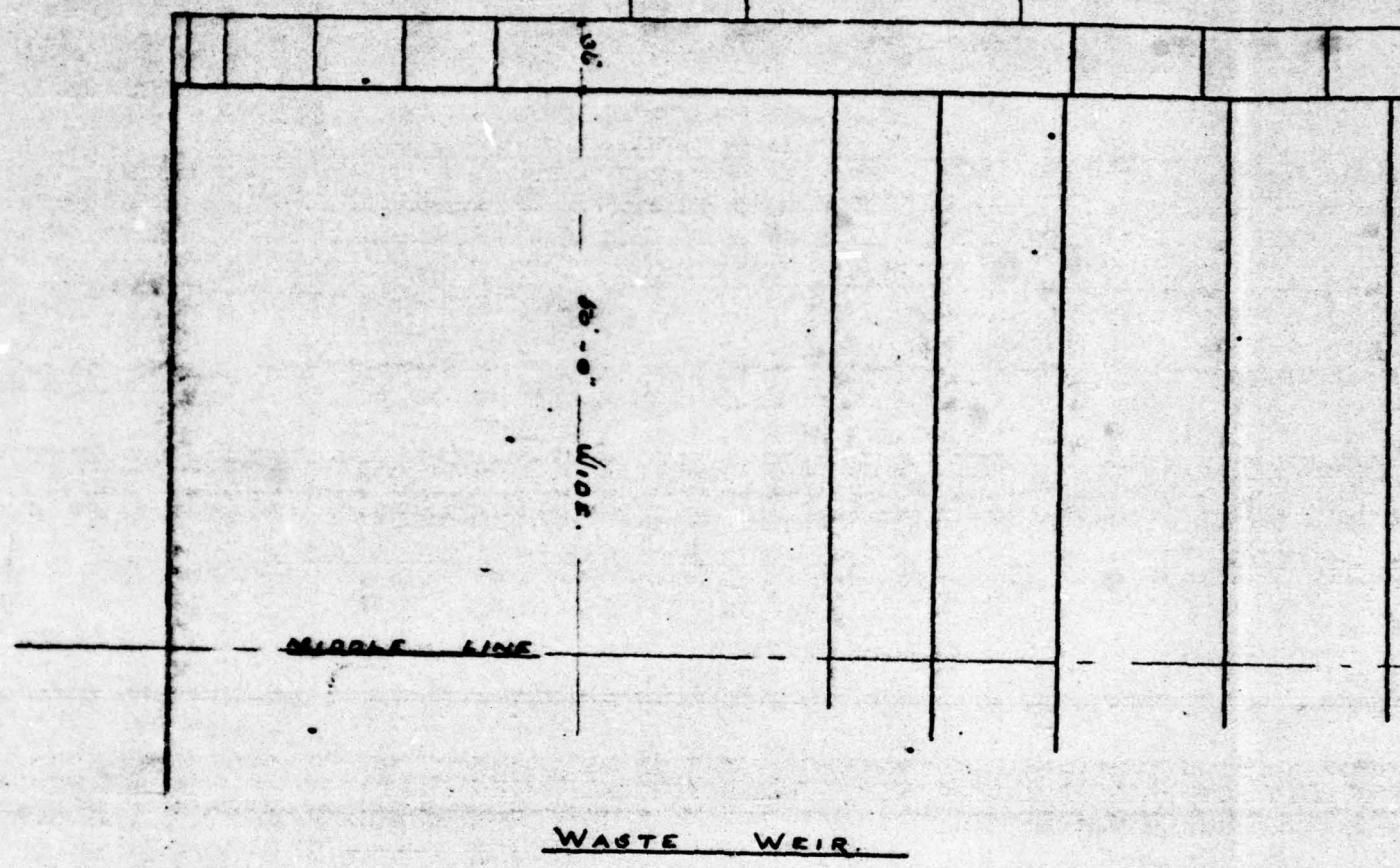
Chartaque Aug 26 '91

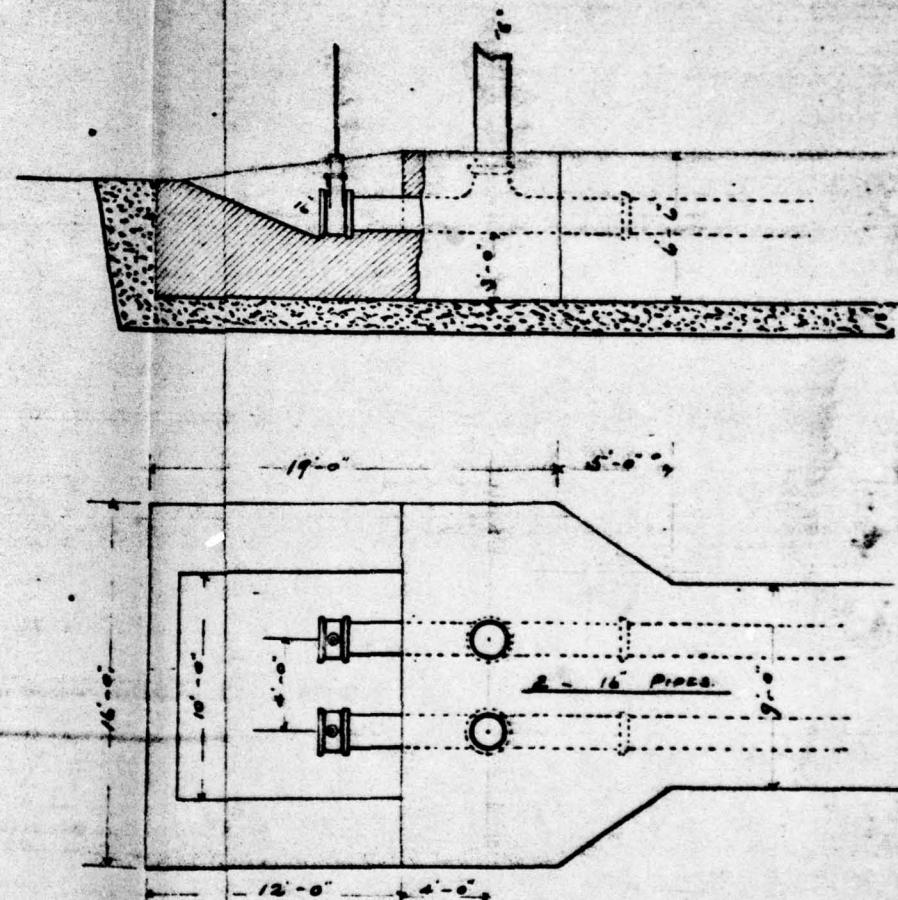
DFORD No. 3.

00,000 GALLONS.

8 CORE WALL
LET PIPES.







DETAIL OF OUTLET PIPES (16")

BRADFORD No. 3.

100,000,000 GALLONS.

Scale $\frac{1}{2}$ in. = one foot.

PLATE 5

Centre of Upper 16" Pipe

Centre of Masonry

Centre of Lower 16" pipe

19' - 0"

16' - 0"

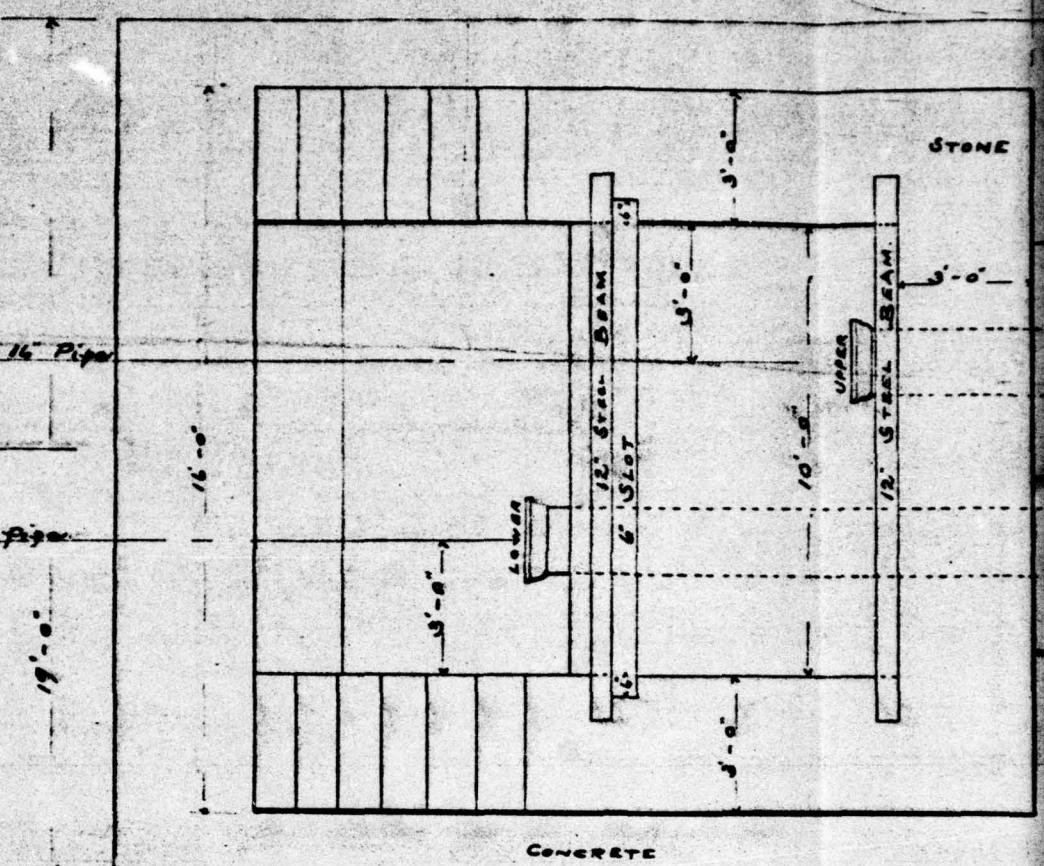
10' - 0"

6' - 0"

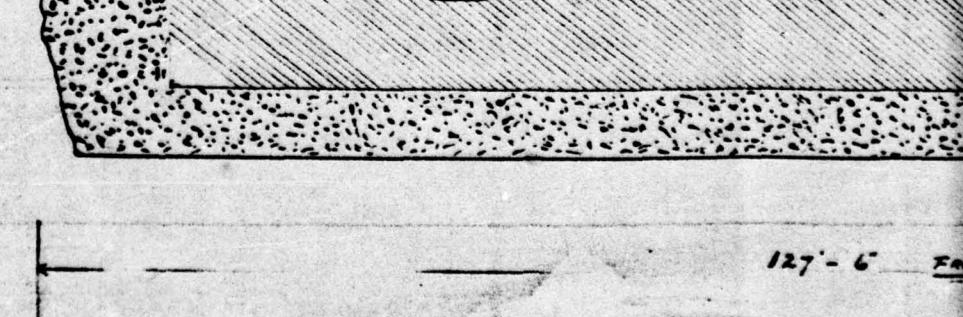
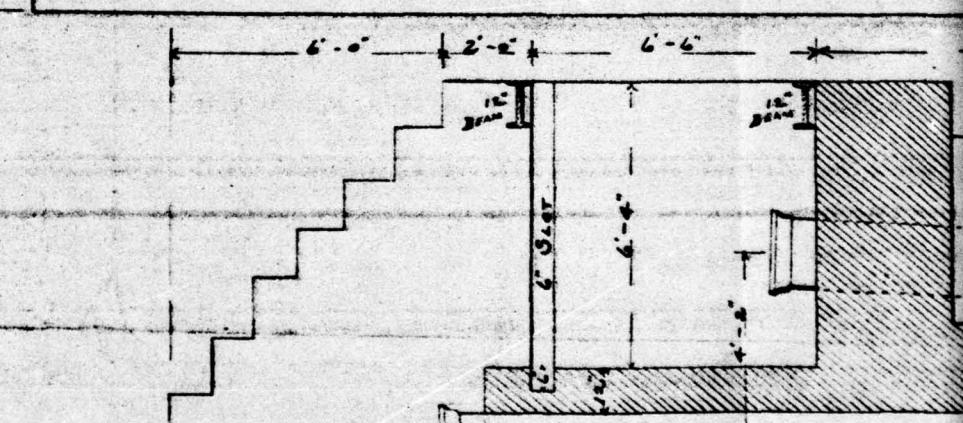
2' - 0"

6' - 6"

12' - 0"

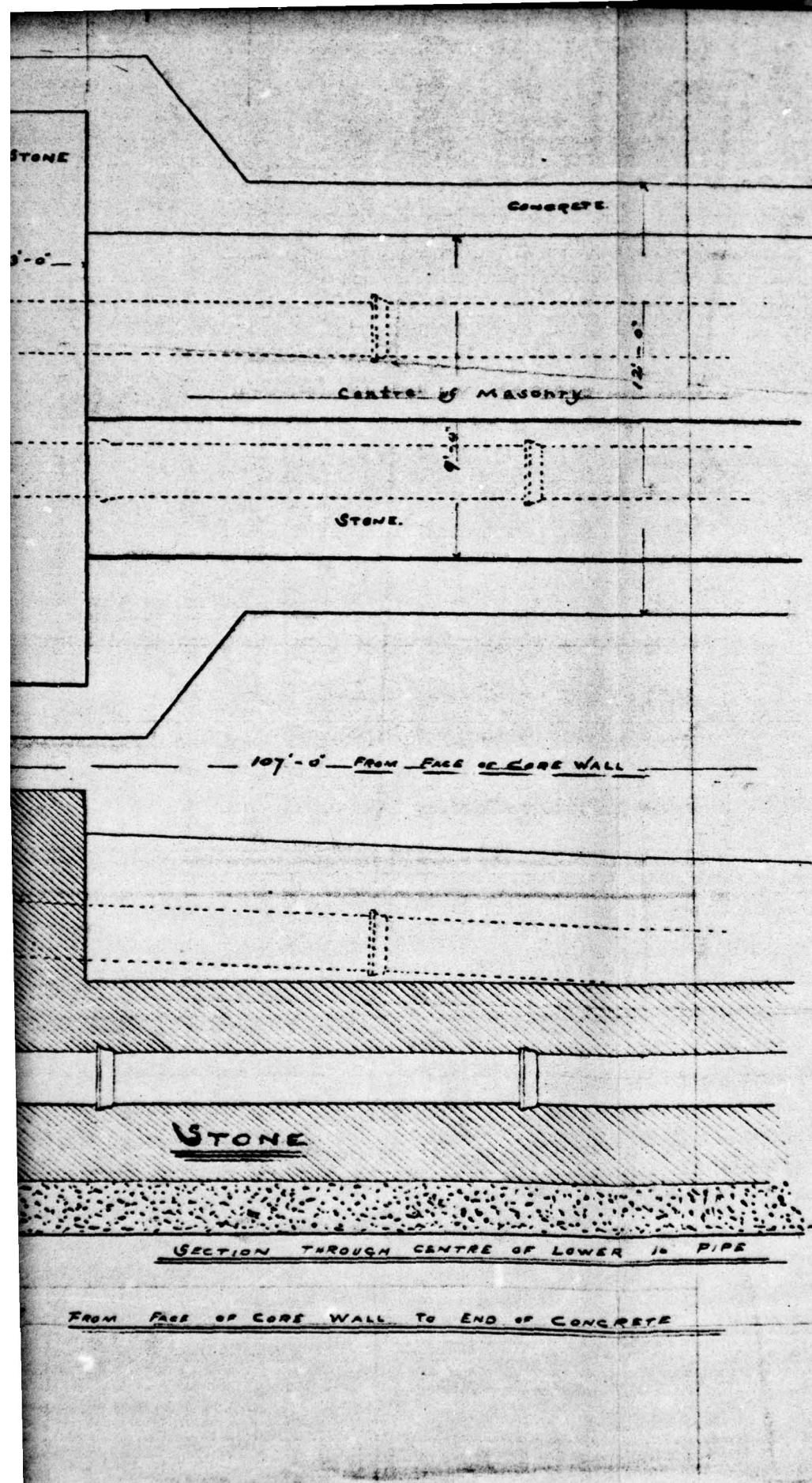


ELEVATION 12' - 0"
RESERVOIR BOTTOM
AT INNER TEE



Chapman Sept 11th 1911

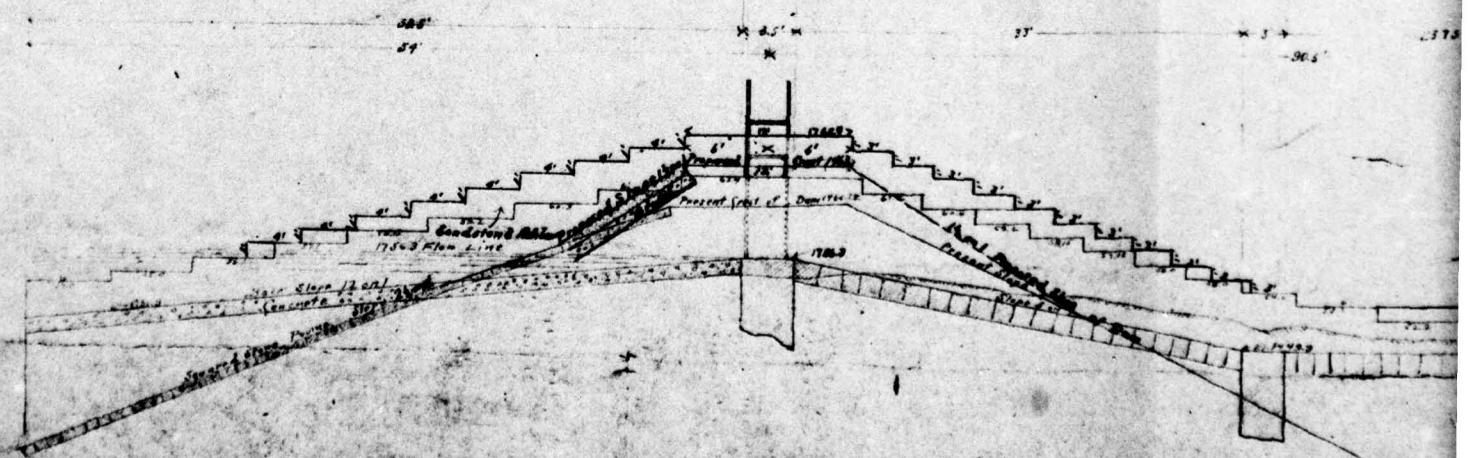
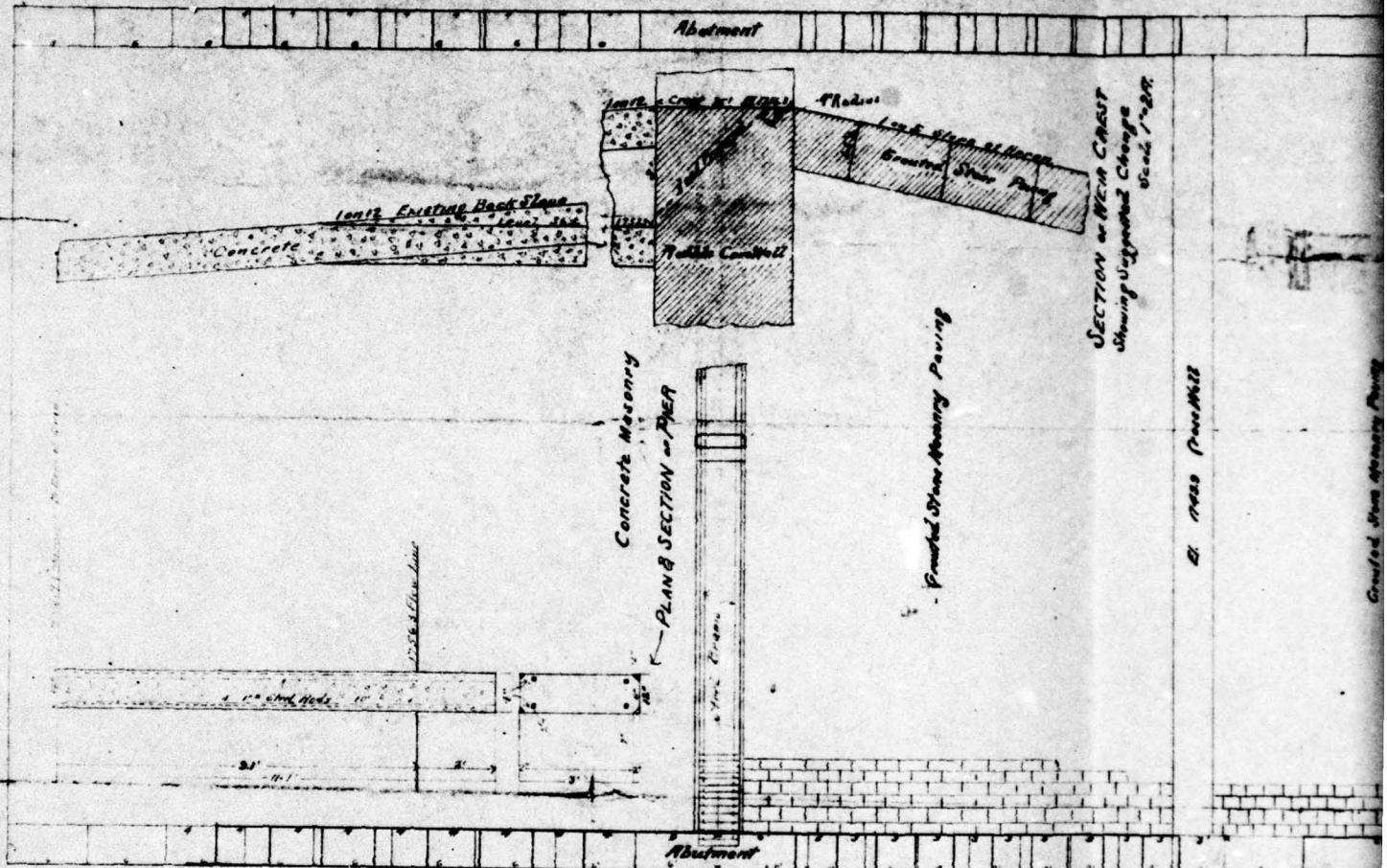
2.



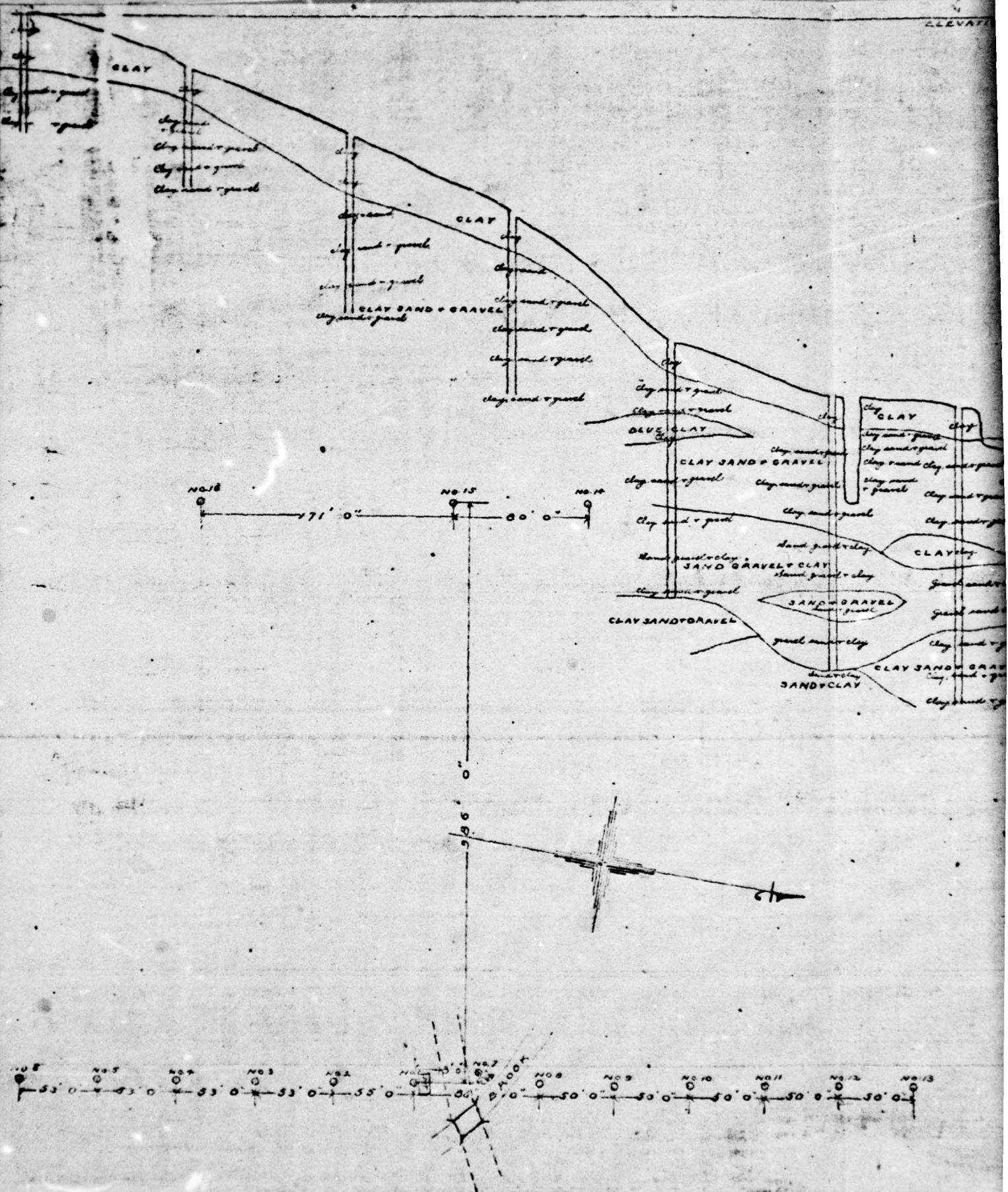
BRADFORD NO. 3.

100,000,000 GALLONS.

Details of outlet Pipes see Screen chamber.

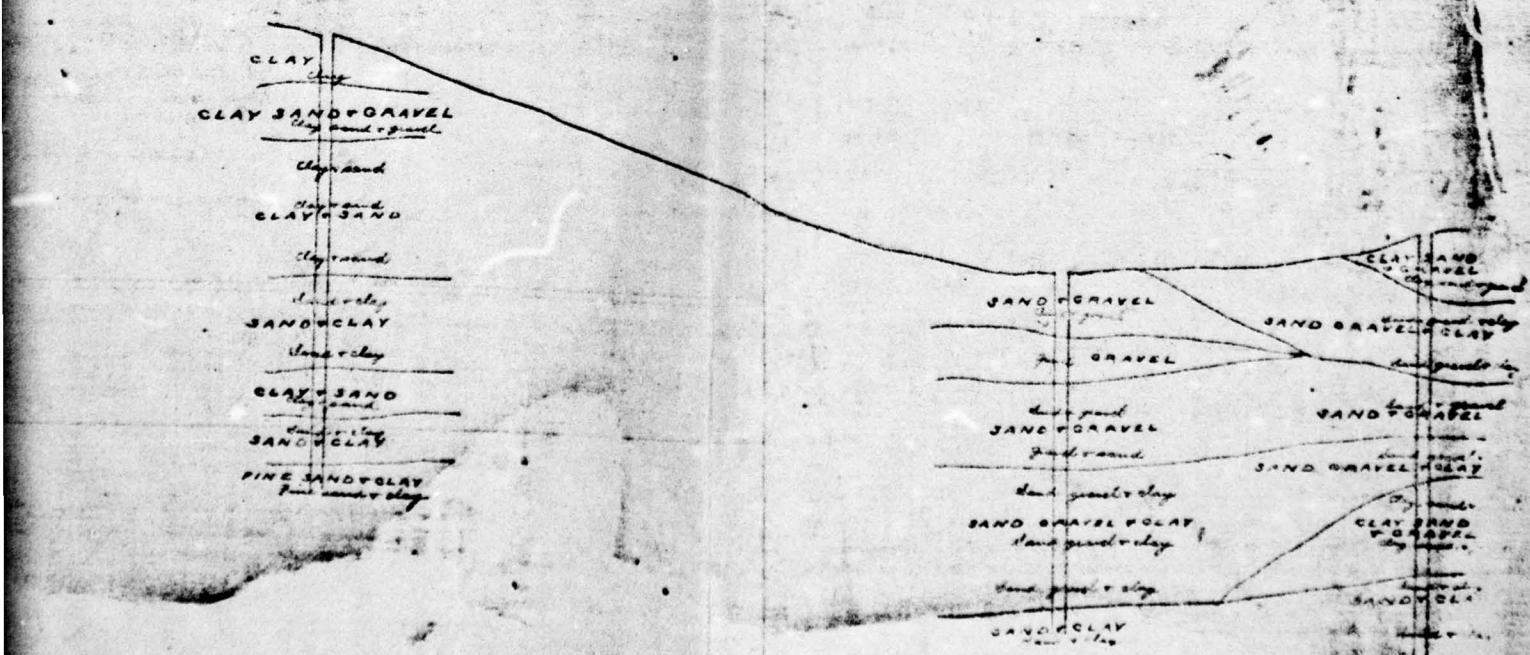
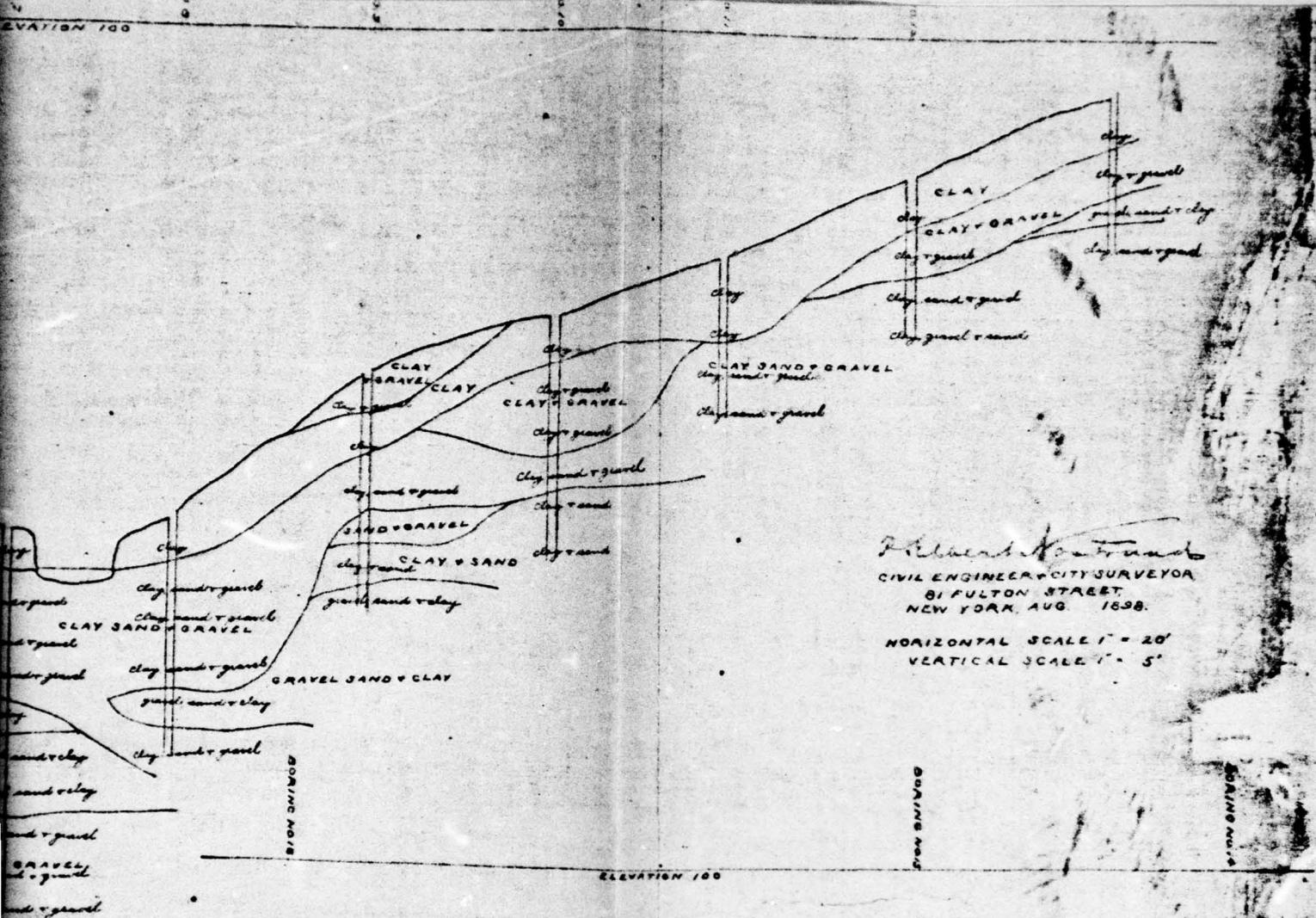


SECTIONAL ELEVATION



Charlottesville Aug 1899

2



Robert H. French
CIVIL ENGINEER & CITY SURVEYOR
81 FULTON STREET,
NEW YORK, AUG. 1698.

CIVIL ENGINEER & CITY SURVEYOR
81 FULTON STREET,
NEW YORK, AUG. 1858.

HORIZONTAL SCALE 1" = 20'
VERTICAL SCALE 1" = 5'

PLATE 8

APPENDIX A

**CHECK LIST - VISUAL INSPECTION
AND FIELD SKETCH**

Check List
Visual Inspection
Phase 1

Name of Dam Bradford City No. 3 Dam County McKean State PA Coordinates Lat. N 41°57.2'
 NDI # PA 00025 Long. W 78°44.4'
 PENNDEER # 42-10

Date(s) Inspection 8 Nov. 1978 Weather Sunny, Clear. Temperature 50°F.

NOTE: Approximate Station 0+00 was assumed at the left abutment of the dam.

Pool Elevation at Time of Inspection 1744.0 ft. M.S.L. Tailwater at Time of Inspection 1717.2 ft. M.S.L.

NOTE: The pool elevation was assumed to be El. 1744.0 ft. as indicated on the U.S.G.S. 7.5 minute topographic quadrangle, Bradford, Pennsylvania. Minor flow (less than 0.1 ft. of water) was flowing over the spillway crest.

Inspection Personnel:

Michael Baker, Jr., Inc.

Thomas W. Smith
James G. Ujinski
Rodney E. Holderbaum

Owner's Representatives
(Bradford City Water Authority):

Pat Nuzzo, Superintendent
Dave Haben, Foreman

Rodney E. Holderbaum Recorder

CONCRETE/MASONRY DAMS (N/A)

Name of Dam: BRADFORD CITY NO. 3
NDI # PA 00025

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

CONCRETE/MASONRY DAMS (N/A)

Name of Dam: BRADFORD CITY NO. 3
NDI # PA 00025

VISUAL EXAMINATION OF OBSEVATIONS REMARKS OR RECOMMENDATIONS

SURFACE CRACKS
CONCRETE SURFACES

STRUCTURAL CRACKING

VERTICAL AND HORIZONTAL
ALIGNMENT

MONOLITH JOINTS

CONSTRUCTION JOINTS

Name of Dam: BRADFORD CITY NO. 3

NDI # PA 00025

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No surface cracks were observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movements or cracking was observed at or beyond the toe of the embankment or	
SLoughing OR Erosion OF EMBANKMENT AND ABUTMENT SLOPES	No sloughing or erosion of the embankment or abutment slopes was observed.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No problems in the horizontal or vertical alignment of the crest alignment of the crest were observed.	
RIPRAP FAILURES	No major problem noted. Hand set riprap consisting of sandstone blocks paves the upstream face. "Pop outs" of the sandstone blocks have occurred at several locations on the upstream face approximately 2 ft. below the crest.	The riprap should be restored to its original condition.

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RODENT/ANIMAL BURROWS	Several rodent/animal burrows were observed. The approximate locations of these holes are shown on the field sketch.	These burrows should be repaired. A groundhog/rodent/animal control program should be implemented.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No problems were observed.	
ANY NOTICEABLE SEEPAGE	Yes, minor seepage exists approximately 575 ft. from the left abutment at the toe of the slope. No evidence of piping was observed. Volume of flow estimated at less than 1 g.p.d. Another seepage area exists at approximate Station 3 + 50 at the toe of the slope. This area did not have any discernible flow, but it appeared to be moist all the time.	The seepage areas noted were not piping fine materials at the time of inspection. These seepage areas were noted in previous inspections performed by engineers from PennDER. The volume of flow is not sufficient to warrant installation of a seepage weir. These seepage areas are not considered detrimental to the present stability of the dam, but they should be examined as a part of future periodic inspections.
STAFF GAGE AND RECORDER	None have been installed.	
DRAINS	No drains are noted on the plans or were observed during the inspection.	

OUTLET WORKS		REMARKS OR RECOMMENDATIONS
VISUAL EXAMINATION OF	OBSERVATIONS	
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit is 16-in. cast-iron; no excessive pitting or corrosion was observed.	
INTAKE STRUCTURE	Not accessible, submerged by reservoir.	
OUTLET STRUCTURE	The outlet head wall consists of sandstone blocks. No problems were observed.	
OUTLET CHANNEL	No excessive debris or vegetation blocking channel; no noticeable erosion.	
EMERGENCY GATE	Valve is located in the gate house at toe of dam and can be used to drain reservoir.	Owner indicated that pond drain is opened bi-annually to insure proper operation.

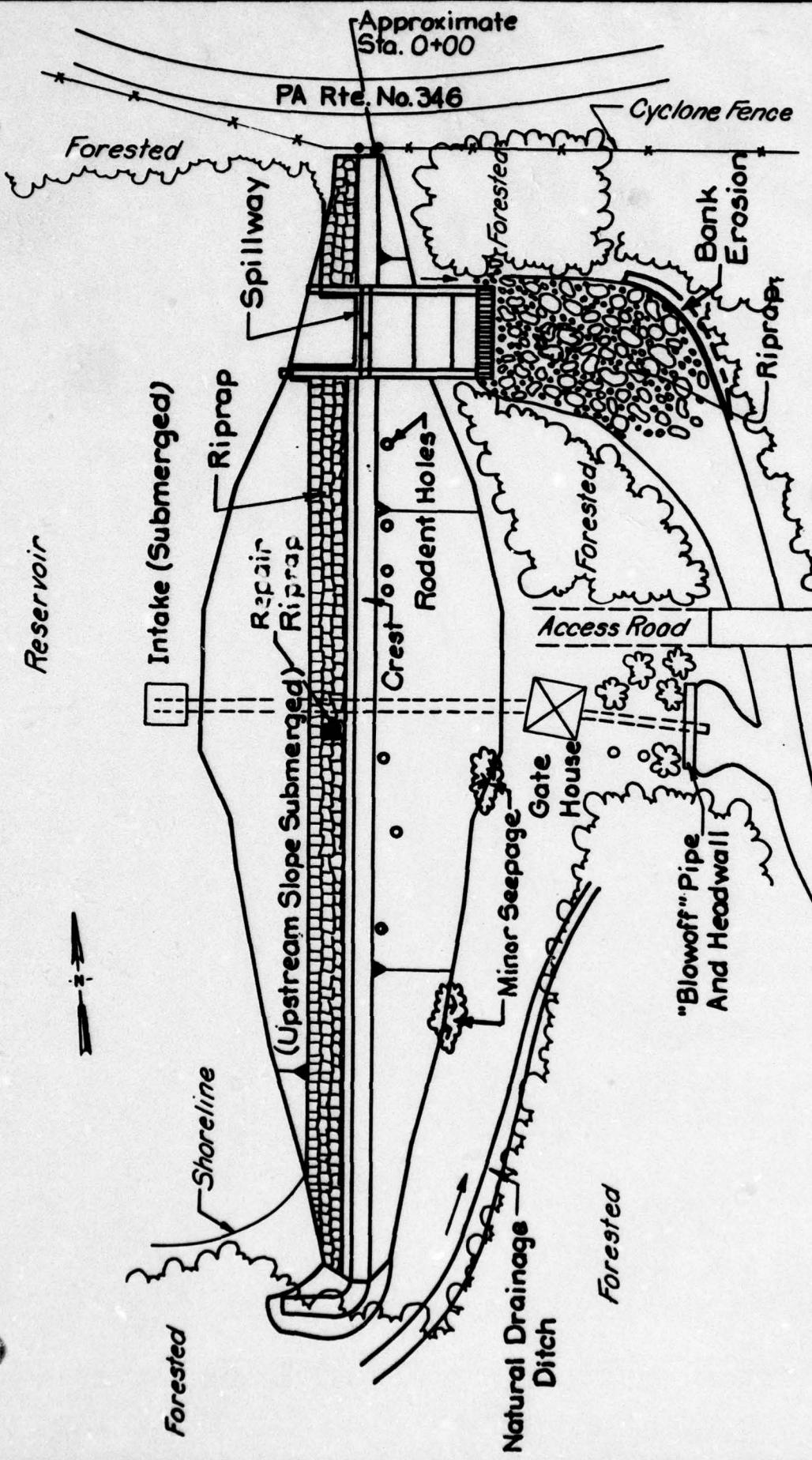
UNGATED SPILLWAY		
NAME OF DAM: BRADFORD CITY NO. 3	NDI # PA 00025	
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	The weir and spillway structure consists of sandstone masonry blocks.	Some of the joints in the masonry wall need repointing.
APPROACH CHANNEL	Approach channel is free of debris and obstruction; no erosion was observed.	
DISCHARGE CHANNEL	Some minor debris and vegetation is located in the discharge channel.	Discharge channel should be checked periodically for debris and vegetation. All debris and vegetation presently in the discharge channel should be removed.
BRIDGE AND PIERS	A 3-ft. wide steel walkway is located directly above and parallel to the spillway crest; one bridge pier is located at the center of the spillway crest.	Steel walkway and bridge pier are in good condition.

Name of Dam: <u>BRADFORD CITY NO. 3</u>	GATED SPILLWAY (N/A)	REMARKS OR RECOMMENDATIONS
NDI # <u>PA 00025</u>		
<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	
<u>CONCRETE SILL</u>		
<u>APPROACH CHANNEL</u>		
<u>DISCHARGE CHANNEL</u>		
<u>BRIDGE AND PIERS</u>		
<u>GATES AND OPERATION EQUIPMENT</u>		

INSTRUMENTATION	
Name of Dam: <u>BRADFORD CITY NO. 3</u>	
NDI # <u>PA 00025</u>	
VISUAL EXAMINATION	
MONUMENTATION/SURVEYS	
OBSERVATION WELLS	
	None observed
WEIRS	
	None observed
PISTOMETERS	
	None observed
OTHER	
	Not applicable

RESERVOIR	
Name of Dam:	BRADFORD CITY NO. 3
NDI #	PA 00025
VISUAL EXAMINATION OF	
SLOPES	The area surrounding the reservoir is gently to moderately sloping and highly forested. No problems were observed.
SEDIMENTATION	No unusual sedimentation was observed.
OBSERVATIONS	
REMARKS OR RECOMMENDATIONS	

DOWNSTREAM CHANNEL	
Name of Dam: <u>BRADFORD CITY NO. 3</u>	NDI # <u>PA 00025</u>
VISUAL EXAMINATION OF	
CONDITION (OBSTRUCTIONS DEBRIS, ETC.)	Downstream channel is clear of debris and obstructions. A small road bridge is located across the stream, but it is not of the constrictive type.
SLOPES	The slope of the downstream channel is moderate to steep, averaging approximately 2% gradient.
APPROXIMATE NO. OF HOMES AND POPULATION	There are approximately 30 residences located in the first mile downstream of the reservoir. From this point to the City of Bradford (about 3.5 miles downstream), there are several hundred homes. The City of Bradford has a population of nearly 13,000 (1970 census).



SCHEMATIC
(Not to Scale)

FIELD SKETCH
Bradford City No 3 Dam, Bradford, PA
NDI # PA 00025

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: BRADFORD CITY NO. 3
NDI # PA 00025

ITEM	REMARKS
PLAN OF DAM	See Plate 3 of this report.

REGIONAL VICINITY MAP A U.S.G.S. 7.5 Minute Topographic Quadrangle, Bradford, Pennsylvania, was used to prepare the vicinity map which is attached in this report as the Location Plan.

CONSTRUCTION HISTORY The dam was constructed in 1898 under the supervision of Mr. Charles A. Hague, who also prepared the plans. Mr. W. M. Hanley, of Bradford, Pennsylvania, was the contractor. No information concerning the method of construction or changes from the design drawings during construction was available.

TYPICAL SECTIONS OF DAM Typical sections of the dam are included as Plates 3 and 4 of this report. Since the dam was designed and constructed in 1898, the details of the drawings may not represent "as built" conditions, however, the general configuration of the dam is as shown on the drawings.

HYDROLOGIC/HYDRAULIC DATA No information available.

OUTLETS - PLAN See Plates 4 and 6 of this report.

- **DETAILS** See Plates 4 and 6 of this report.
- **CONSTRAINTS** The 16-in. pipe is controlled by a valve located at the gate house.
- **DISCHARGE RATINGS** No discharge ratings for the outlet pipes were available.

RAINFALL/RESERVOIR RECORDS No records are available at the dam site.

Name of Dam: BRADFORD CITY NO. 3
 NDI # PA 00025

ITEM		REMARKS
DESIGN REPORTS	No	design reports were available.

GEOLOGY REPORTS No geology reports were available. However, a general description of the geology is presented as Appendix E of this report.

DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

In 1923, the height of embankment was raised approximately 3 ft. With the raising of embankment, the hydraulic capacity was calculated to be 2200 c.f.s. when 5.7 ft. of water was flowing over the spillway crest (or 1 ft. below the top of embankment). These calculations were performed by the Water Supply Commission of Pennsylvania (predecessor of PennDER) and are present in PennDER's file for this dam. No other design computations are available.

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD

The original soil borings and soil profile is presented as Plate 6 of this report. The record of borings, made under the direction of Elbert Nostrand, Engineer and Surveyor, of New York, New York, was prepared in August 1898 and was attached to the set of original blueprints borrowed from the Bradford City Water Department.

POST-CONSTRUCTION SURVEYS OF DAM No information concerning post-construction surveys of the dam was available.

BORROW SOURCES According to information contained in the PennDER correspondence files, material for the earth embankment was taken from the upper end of the reservoir. Other information noting the exact location is not available.

Name of Dam:	BRADFORD CITY NO. 3
NDI #	PA 00025
ITEM	REMARKS

MODIFICATIONS In 1923, the embankment was raised 3 ft. by T. J. Callahan, Contractor, to increase the hydraulic capacity of the spillway before overtopping would occur. At the same time, the spillway approach channel was repaved with 12 in. of reinforced concrete.

HIGH POOL RECORDS No detailed records are available.

POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS In 1915, the Water Supply Commission of Pennsylvania made an inspection and short report of the dam. Since the 1915 inspection, the dam has been inspected an additional 18 times. These inspection reports are available in the PennDER file for this dam.

PRIOR ACCIDENTS OR FAILURE OF DAM No prior accidents or failure of the dam have been noted.
DESCRIPTION REPORTS

Maintenance
OPERATION
RECORDS No maintenance or operation records are available.

Name of Dam: BRADFORD CITY NO. 3

NDI # PA 00025

ITEM

REMARKS

SPILLWAY PLAN See Plates 5 and 7 of this report.

SECTIONS

DETAILS

OPERATING EQUIPMENT
PLANS & DETAILS

See Plate 5 of this report. This is an original design drawing and may not represent the "as built" condition. Subsequent to the construction of the dam, a pump house was constructed over the downstream valve chamber. It is not known what modifications were performed at that time.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 4.8 sq.mi. (forested)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1744.0 ft. (368 ac.-ft.)

ELEVATION AVERAGE TOP OF DAM (STORAGE CAPACITY): 1750.8 ft. (502 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1750.8 ft. (average elevation), 1750.4 ft. (minimum elevation)

CREST: Principal Spillway

- a. Elevation 1744.0 ft.
- b. Type Overflow spillway through embankment of dam
- c. Width 58.6 ft.
- d. Length 89 ft. from crest to downstream end of spillway
- e. Location Spillover Approximately 90 ft. from left abutment of dam
- f. Number and Type of Gates None

OUTLET WORKS: Pipe Outlet

- a. Type 16-in. cast-iron pipe
- b. Location Approximate center of dam
- c. Entrance inverts Unknown
- d. Exit inverts 1716.3 ft.
- e. Emergency draindown facilities Gated 16-in. C.I.P.

HYDROMETEOROLOGICAL GAGES: None

- a. Type
- b. Location
- c. Records

MAXIMUM NON-DAMAGING DISCHARGE Not available

APPENDIX C

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam

Upstream - View From Left Abutment Looking South Along
Upstream Crest of the Dam - 8 November 1978
(Spillway walls and bridge in center of photo.)

Downstream - View From Left Side of Spillway Looking South
Along Downstream Slope of the Embankment -
8 November 1978

Photo 1: View of Upstream Portion of the Spillway -
8 November 1978

Photo 2: View of Downstream Portion of the Spillway -
9 November 1978

Photo 3: View of Outlet Pipe and Outlet Pipe Head Wall -
9 November 1978

Photo 4: View Looking Upstream at the Bridge Across the
Downstream Channel - 9 November 1978

BRADFORD CITY No. 3 DAM

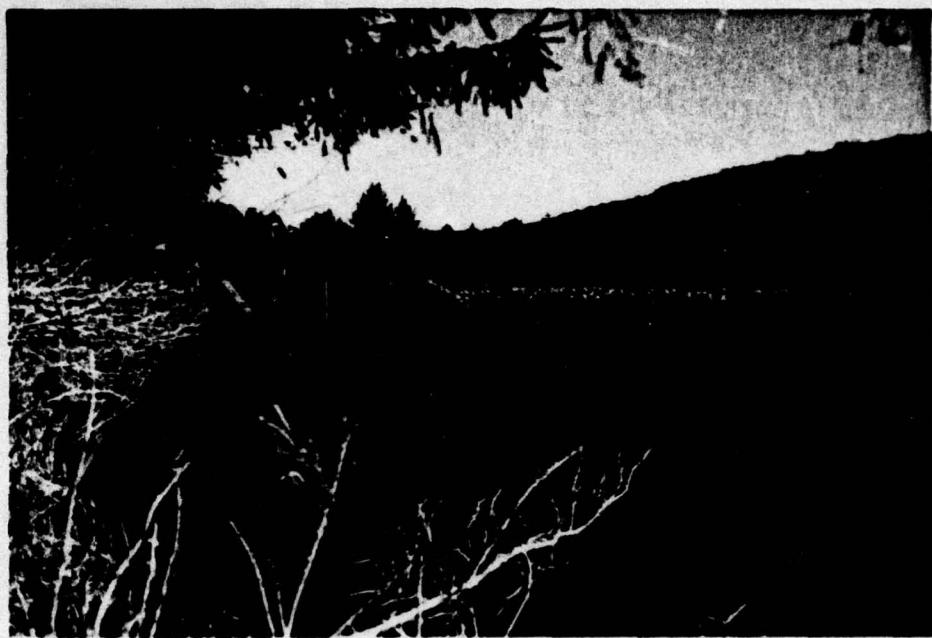


PHOTO 1. View of Upstream Portion of Spillway

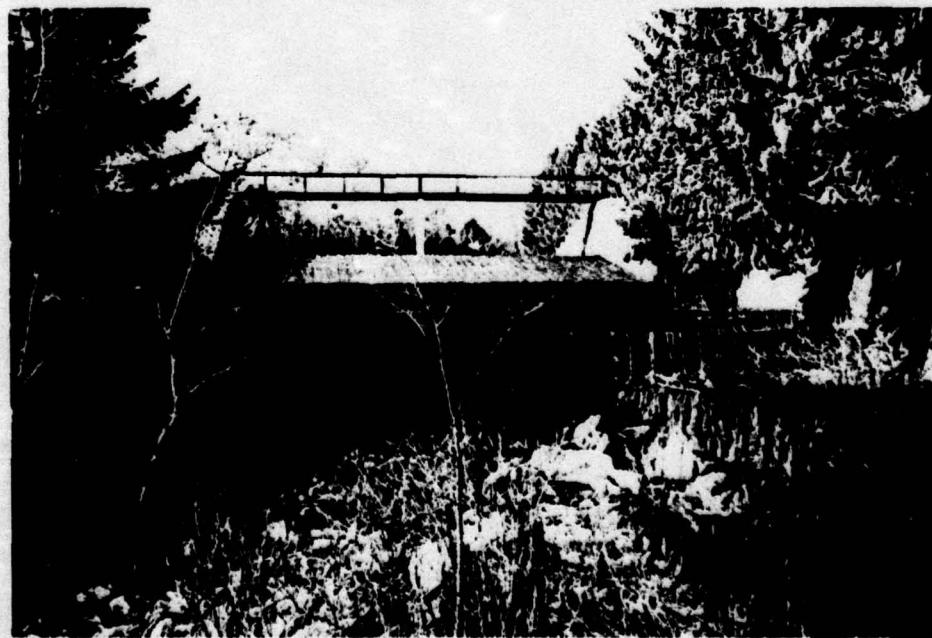


PHOTO 2. View of Downstream Portion of Spillway

BRADFORD CITY No. 3 DAM

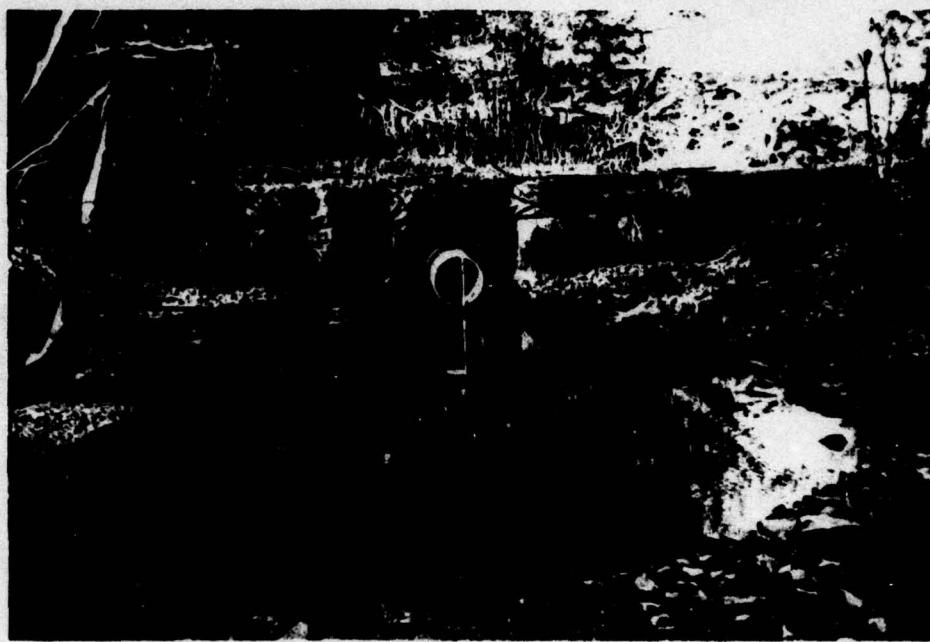


PHOTO 3. View of Outlet Pipe and Outlet Pipe Head Wall



PHOTO 4. View Looking Upstream at Bridge Across Downstream Channel

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford No. 3 S.O. No. _____

Sheet No. _____ of _____

Drawing No. _____

Computed by _____ Checked by _____ Date _____

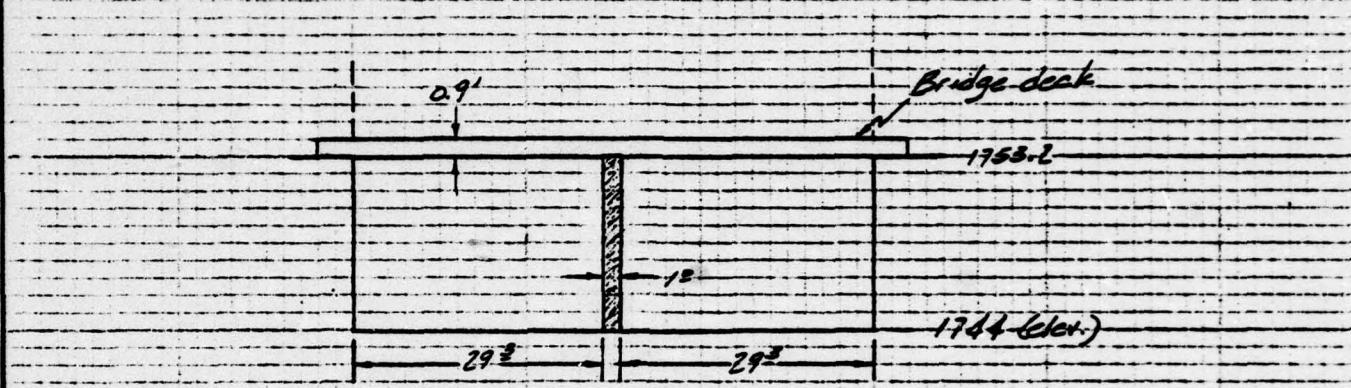
Table of Contents

Spillway Rating	1-1
Top of Dam Profile	3
Hydrology (Snyder)	4
EMTP, Storage, Overtopping Data	5
Damage Area Map	6
Flood Ratings	7-12

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject PA Dam Inspections S.O. No. _____
Bradford City No. 3 Sheet No. 1 of 12
Spillway Rating Drawing No. _____
Computed by REH Checked by _____ Date 12-8-78



Q (cfs)	g (cfs/ft)	de (ft)	A (ft ²)	V (ft ³)	$V^{2/3}$ /29	ES (ft.)	$NSEL$ (ft.)
100	1.71	0.45	26.30	3.00	0.22	0.67	44.67
400	6.83	1.13	66.28	8.03	0.57	1.70	85.70
800	13.65	1.00	105.21	1.60	0.90	2.70	16.70
1200	20.48	2.35	137.87	8.10	1.18	3.53	47.53
1600	27.30	2.85	167.02	9.58	1.43	4.28	48.28
2000	34.13	3.31	193.80	10.32	1.65	4.96	48.96
2500	42.66	3.84	224.89	11.12	1.92	5.76	49.76
3000	51.19	4.33	253.95	11.81	2.17	6.50	50.50
3500	59.73	4.80	281.44	12.44	2.40	7.20	51.20
4000	68.26	5.24	307.14	13.02	2.63	7.87	51.87
4500	76.79	5.60	332.72	13.57	2.84	8.52	52.52
5000	85.32	6.09	356.99	14.01	3.05	9.14	53.14
6000	102.39	6.88					

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

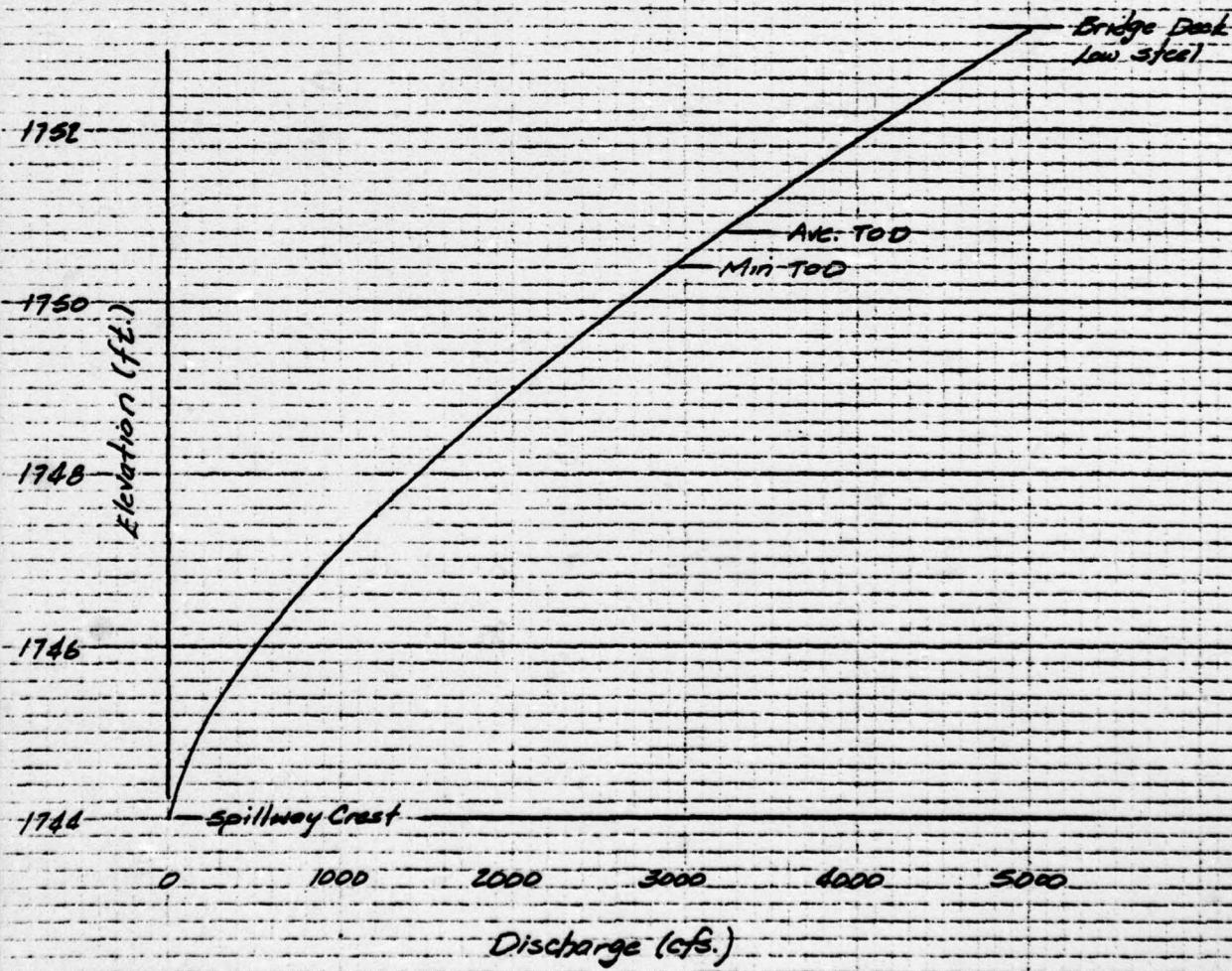
Box 280
Beaver, Pa. 15009

Subject PA Dam Inspections S.O. No. _____
Bradford City No. 3 Sheet No. 2 of 12
Spillway Rating Drawing No. _____
Computed by REH Checked by _____ Date 12-11-78

Where:

$$q = \rho g h c \quad A = d_c (58.6) \quad EG = d_c s + \frac{q^2}{2g}$$

$$d_c = \sqrt{\frac{q^2}{g}} \quad V = q/A \quad HSEL = 17.64 + EG$$



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject PA Dam Inspections

S.O. No.

Bradford No. 3

Sheet No. 3 of 12

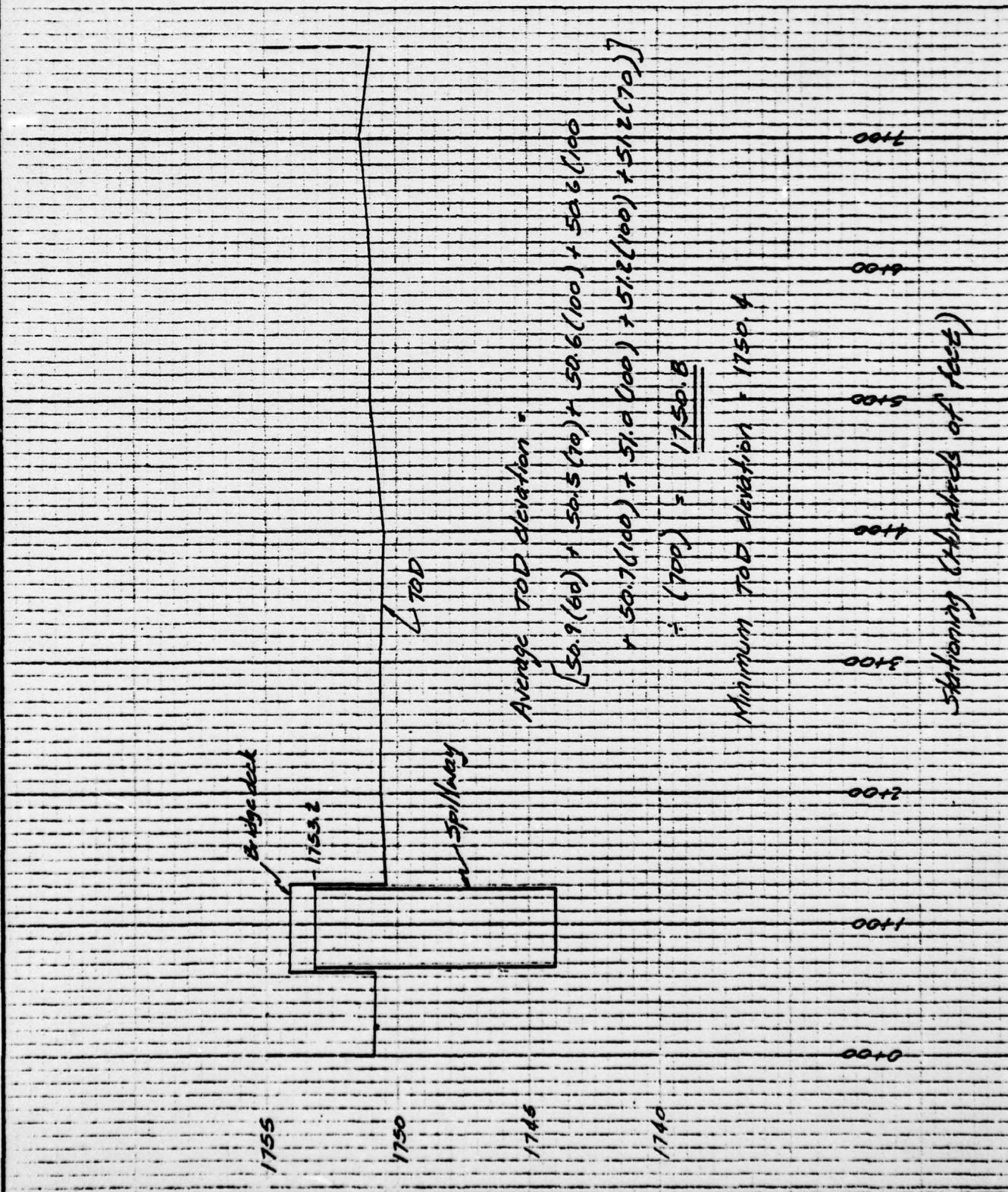
TOD Profile

Drawing No.

Computed by PEH

Checked by

Date 12/8/78



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford No. 3 Dam S.O. No. _____
Hydrology - Snyders Method Sheet No. 4 of 12
Drawing No. _____
Computed by DIG Checked by _____ Date _____

Area 13 \Rightarrow $c_p = 0.55$, use plate 1 for c_1

Sub-basin A

$$L_p = 3.3 \left(\frac{h}{\text{cm}} \right)^{0.8}$$

$$t_{p} = 3.3 \left[\left(\frac{15000}{3100} \right) \left(\frac{6500}{5100} \right) \right]^{0.5} = 4.57 \text{ hours}$$

adjustment to 30 min. duration.

$$E_p = 4.57 + 0.25 (0.5 - 4.5) / 5 = 4.19 \text{ Joules}$$

Sub-basin B

$$1p = 3.3 \text{ (kca)}^{0.5}$$

$$LP = 3.3 \left[\left(\frac{11900}{3280} \right) \left(\frac{6000}{3280} \right) \right]^{0.5} = 5.41 \text{ hours}$$

adjustment to 30 min. duration.

$$t_{\text{pre}} = 5.01 + 0.25 (0.5 - 50\%/\text{sec}) = 5.19 \text{ hours}$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford Number 3

S.O. No.

PMP. storage, overtopping
Data

Sheet No. 5 of 12

Computed by REH

Checked by _____

Drawing No.

Date 1-7-79

PMP Estimate (from HMR-33)

$PMP \approx 22.5 \text{ inches}$

Zone 2 Ratios	6 hr	111%
12 hr	111%	
24 hr	131%	
48 hr	151%	

Reservoir Storage

Normal Pool 120 m.g. = 360.3 A.F. (From DER file)

$\Delta E = \frac{33}{\text{Area}} = \frac{3(360.3)}{18.18} = 60.73 \text{ ft. } E.L. = 1704 - 60.73 = 1643.3 \text{ ft.}$

Elev. 1746.0 Area = $230.18 \text{ m}^2 \left(\frac{50^2}{\text{m}^2}\right) \frac{1 \text{ Ac.}}{43560 \text{ ft}^2} = 19.02 \text{ Ac.}$

Overtopping Rating

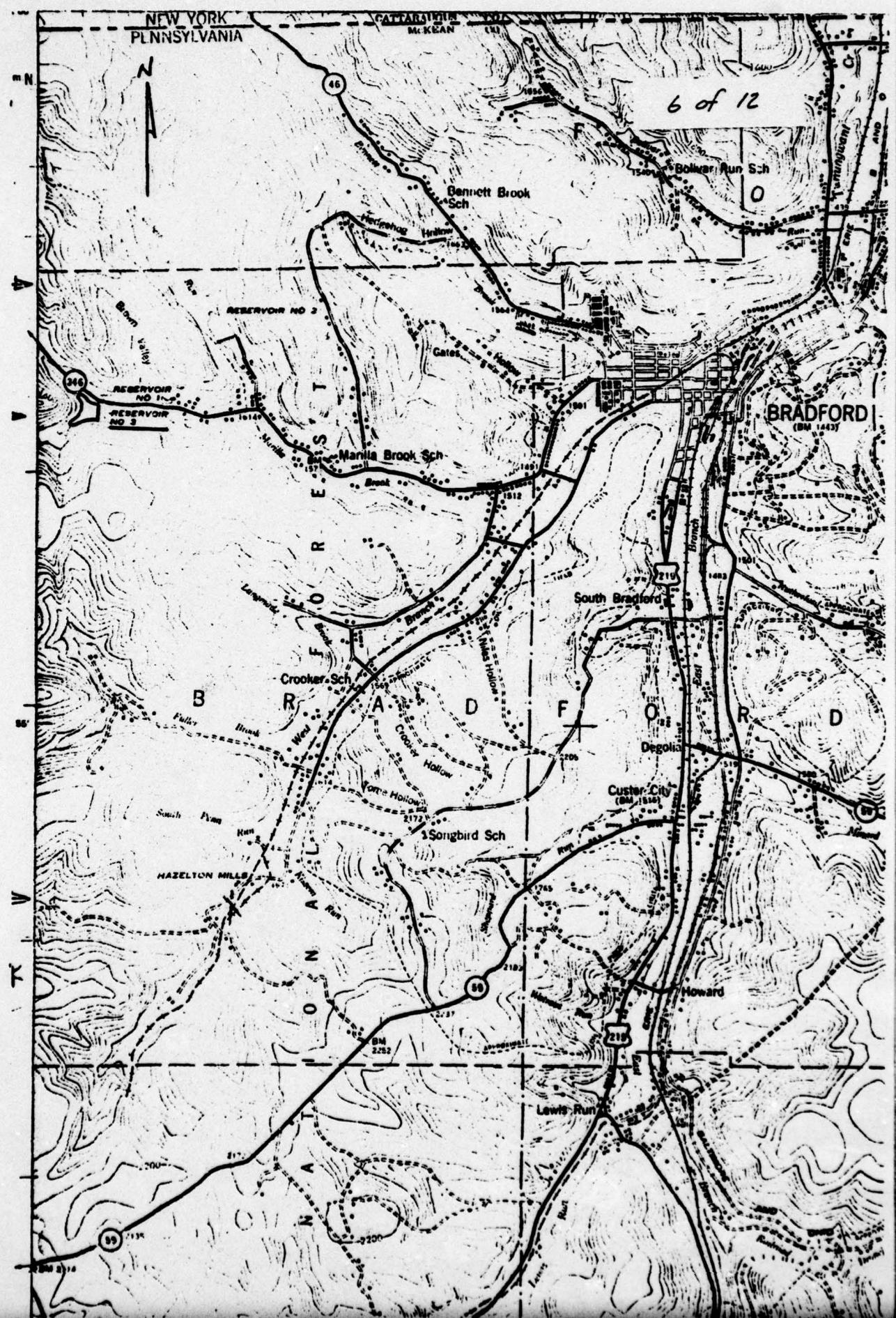
Average Top of Dam Elev = 1750.5 feet

Dam length to elev 1753.2 = $600 + 62 = 702 \text{ ft.}$

Width of Crest = 12 ft. (overwidth) = 2.64

from: Handbook of Hydraulics

King & Brater pg. 5-46



FLOOD HYDROGRAPH PACKAGE (MEC-11)
DM SAFETY VERSION July 1978
LAST MODIFICATION 25 SEP 78

FLOOD HYDROGRAPH PACKAGE (MEC-1)										
DAM SAFETY VERSION										
LAST MODIFICATION 25 SEP 78										

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS										
1	41	HYDROLOGIC AND HYDRAULIC ANALYSIS OF BRADFORD CITY NO. 3 M&J 19								
2	42	PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SANDERS METHOD								
3	43	*****								
4	8	250	0	30	0	0	0	0	0	
5	81	5	0	0	0	0	0	0	0	
6	1	1	1	1	1	1	1	1	1	
7	71	1.0	0.5	0.4	0.3					
8	K	TRIB-B								
9	K1	THIS IS THE INFLOW HYDROGRAPH TO DAM NO. 3 FROM SOUTHWEST TRIBUTARY								
10	1	1	1	3.19	4.03					
11	P	P	22.8	117	127	141	191			
12	T	T						1.0	.05	
13	X	5.29	.55							
14	X	-1.5	-0.05	2.0						
15	K	TRIB-A								
16	K1	THIS IS THE INFLOW HYDROGRAPH TO DAM NO.3 FROM THE NORTHEAST TRIBUTARY								
17	1	1	1	1.64	4.03					
18	P	P	22.8	117	127	141	151			
19	T	T						1.0	.05	
20	X	4.49	.55							
21	X	-1.5	-0.05	2.0						
22	K	2	LAKE							
23	K1	COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM								
24	K	1	SPHY							
25	K1	THIS IS THE ROUTING OF THE COMBINED FLOWS MIN T00=1750.4 AVG T00=1750								
26	Y	1	1	1	1	1	1			
27	Y1	1	1	1	1	1	1			
28	Y4	1744.67	1745.70	1746.70	1747.53	1748.28	1749.96	1750.50	1751.0	
29	Y41751.9	1752.52	1753.14							
30	Y5	100	400	800	1200	1600	2000	2500	3000	
31	Y5	4000	4500	5000						
32	SA	16.19	19.02	26.63						
33	SE16683.3	1744	1746	1760						
34	SA	1744								
35	SE1750.8	2.64	1.5	1.02						
36	K	99								

7 of 12

FLOOD HYDROGRAPH PACKAGE JHEC-11
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78

RUN DATE 02/13/79
TIME 08:35

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF BRADFORD CITY NO. 3 M&J 19
PROBABLE MAXIMUM FLOOD PFM/UNIT GRAPH BY SNADERS METHOD

NO	NHHR	NMIN	IDAY	1HR	1MIN	NETAC	JPLT	JPT	NTSM
250	0	30	0	0	0	0	0	-4	0
				10	0	0	0		
				20	0	0	0		
				30	0	0	0		
				40	0	0	0		
				50	0	0	0		
				60	0	0	0		
				70	0	0	0		
				80	0	0	0		
				90	0	0	0		
				100	0	0	0		
				110	0	0	0		
				120	0	0	0		
				130	0	0	0		
				140	0	0	0		
				150	0	0	0		
				160	0	0	0		
				170	0	0	0		
				180	0	0	0		
				190	0	0	0		
				200	0	0	0		
				210	0	0	0		
				220	0	0	0		
				230	0	0	0		
				240	0	0	0		
				250	0	0	0		
				260	0	0	0		
				270	0	0	0		
				280	0	0	0		
				290	0	0	0		
				300	0	0	0		
				310	0	0	0		
				320	0	0	0		
				330	0	0	0		
				340	0	0	0		
				350	0	0	0		
				360	0	0	0		
				370	0	0	0		
				380	0	0	0		
				390	0	0	0		
				400	0	0	0		
				410	0	0	0		
				420	0	0	0		
				430	0	0	0		
				440	0	0	0		
				450	0	0	0		
				460	0	0	0		
				470	0	0	0		
				480	0	0	0		
				490	0	0	0		
				500	0	0	0		
				510	0	0	0		
				520	0	0	0		
				530	0	0	0		
				540	0	0	0		
				550	0	0	0		
				560	0	0	0		
				570	0	0	0		
				580	0	0	0		
				590	0	0	0		
				600	0	0	0		
				610	0	0	0		
				620	0	0	0		
				630	0	0	0		
				640	0	0	0		
				650	0	0	0		
				660	0	0	0		
				670	0	0	0		
				680	0	0	0		
				690	0	0	0		
				700	0	0	0		
				710	0	0	0		
				720	0	0	0		
				730	0	0	0		
				740	0	0	0		
				750	0	0	0		
				760	0	0	0		
				770	0	0	0		
				780	0	0	0		
				790	0	0	0		
				800	0	0	0		
				810	0	0	0		
				820	0	0	0		
				830	0	0	0		
				840	0	0	0		
				850	0	0	0		
				860	0	0	0		
				870	0	0	0		
				880	0	0	0		
				890	0	0	0		
				900	0	0	0		
				910	0	0	0		
				920	0	0	0		
				930	0	0	0		
				940	0	0	0		
				950	0	0	0		
				960	0	0	0		
				970	0	0	0		
				980	0	0	0		
				990	0	0	0		
				1000	0	0	0		

MULTI-PLAN ANALYSES TO BE PERFORMED

MPLAN= 1 NPTIO= 4 LRTIO= 1
RTIOS= 1.00 0.50 0.40 0.30

SUB-AREA RUNOFF COMPUTATION

THIS IS THE INFLOW HYDROGRAPH TO DAM NO. 3 FROM SOUTHWEST TAI BUTARY

STAGE	TUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNON	ISAME	LOCAL
TRIB-8	0	0	0.0	4.83	0.0	0.0	0	0	0
SPFF	0.0	222.80	117.00	127.00	141.00	R48	R72	R96	

TRSPC COMPUTED BY THE PROGRAM IS 0.000
TP= 5.29 CP=0.55 NTIA= 0
LOSS DATA
STAGE= 0.00 SNCSN= -0.05 RTIOR= 2.00
RECEDENCE DATA

UNIT HYDROGRAPH 73 END-OF-PERIOD ORDINATES, LAG= 5.28 HOURS, CP= 0.55 VOL= 1.00
6. 100. 131. 160. 184. 214.
22. 197. 182. 169. 155. 143. 202.
211. 191. 181. 175. 69. 132. 112.
104. 96. 88. 81. 75. 59. 54.
44. 43. 40. 36. 31. 29. 24.
21. 19. 16. 15. 14. 13. 12.
8 of 12

9.	4.	2.
9.	4.	2.
8.	4.	2.
7.	3.	
6.	3.	
5.	2.	
5.	2.	
5.	2.	

0	END-OF-PERIOD FLOW				LOSS	EXCS	LOSS	COMP Q
	NO.DA	HR.MN	PERIOD	RAIN				
COMP Q	NO.DA	HR.MN	PERIOD	RAIN				

3500	27.54	23.11	2.43	103010.
1700.	11	638.11	62.11	2938.581

SUBAREA B1: INDEE COMMUNICATI

THIS IS THE INFO ON HYDROGRAPHY TO DAM NO. 3 FROM THE NORTHWEST TRIBUTARY

1STAGE 1C100 1E100 1T100 1S100 1T100 1NAME 1STAGE

卷之三

卷之三

卷之三

STAKER DLYNE S1101 ERAIN STAKS S102 CNTL ALSPX NTMP

卷之三

TP = 0.69 CP = 0.25 NTA = 0

RECESSION DATA

117.	34.	54.	76.	97.	114.	126.	132.
------	-----	-----	-----	-----	------	------	------

62. 39. 35. 32. 29. 26. 24. 23.

ପାତା ୫୫

卷之三

0 DA HR.MN PERIOD RAIN EXCS LOSS COMP Q END-OF-PERIOD FLOW MD.D

111

1700.11 638.11 62.11 1518.031

卷之三

CUMBIINE HYDRUROGRAPHS

THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM

9 of 12

21

LAKE 2 0 0 0 0 0 0 1 0 0 0

HYDROGRAPH ROUTING

THIS IS THE ROUTING OF THE COMBINED FLOWS. MIN FLO=1730.4 AVG FLO=1759.8

	1STAO SPMV	ICOMP L	IECON 0	ITAPE 0	JPLT 0	JPRT 0	I NAME 0	I STAGE 1	I AUTO 0
LOSS	0.0	0.0	0.0	ROUTING DATA					
QLOSS	0.0	0.0	0.0	ROUTING DATA					
NSTPS	1	0	0	ROUTING DATA					
STAGE	1744.00 1721.90	1744.67 1752.52	1745.70 1753.14	1746.70	1747.53	1748.28	1748.96	1749.76	1750.50
FLOW	0.0 4000.00	100.00 4500.00	400.00 5000.00	800.00	1200.00	1600.00	2000.00	2500.00	3000.00
SURFACE AREA	0.	16.	19.	21.					3500.00
CAPACITY	0.	368.	405.	723.					
ELEVATION	1683.	1744.	1746.	1748.					
CREL	1744.0	SPHID 0.0	COAM 0.0	EXPN 0.0	ELEV 0.0	COOL 0.0	CAREA 0.0	EXPL 0.0	
					DAM DATA				
					TOPEL 1750.0	COOD 2.6	EXPD 1.5	DAMID 702.	

PEAK QOUTFLOW IS 6645. AT TIME 44:50 HOURS

PEAK QOUTFLOW IS 3306. AT TIME 45:00 HOURS

PEAK QOUTFLOW IS 2440. AT TIME 45:00 HOURS

PEAK QOUTFLOW IS 1927. AT TIME 45:00 HOURS

10 of 12

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLANNING ECONOMIC COMPUTATIONS
 FEET IN CUBIC FEET PER SECOND CUBIC METERS PER SECOND
 AREA IN SQUARE MILES / SQUARE KILOMETERS

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
				1.00	0.90	0.80	0.70	0.60
HYDROGRAPH AT TRIB-8		3.10	1	3226.	2113.	1691.	1298.	829.
	(0.26)	(	1	119.6811	59.0611	47.0311	35.9011	25.7711
HYDROGRAPH AT TRIB-10		1.64	1	2466.	1233.	987.	749.	546.
	(4.25)	(	1	69.8411	36.9211	27.9311	20.9511	14.9711
2. COMBINED LAKE		4.03	1	6653.	3326.	2661.	1926.	1296.
	(12.51)	(	1	188.3911	94.1911	75.3911	56.3211	36.3211
ROUTED TO SPHY		4.03	1	6645.	3306.	2649.	1927.	1297.
	(12.51)	(	1	188.1711	93.6211	74.7511	56.0011	36.0011

11 of 12

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL ELEVATION	SPILLWAY CREST	TOP OF DAM	MAXIMUM TOP OF DAM
		1744.90	1744.90	1750.80	1750.80
		STORAGE	368.	368.	502.
		OUTFLOW	0.	0.	3214.
		MAXIMUM DEPTH			
		AVG	MAX	MAX	TIME OF
		DEPTH	DEPTH	OUTFLOW	TIME OF
		OVER DAM	AC-FT	CFS	FAILURE
		RESERVOIR	MAXIMUM	OVER TOP	MAX. OUTFLOW
		W.S. ELEV	AC-FT	HOURS	HOURS
1.00	1752.03	1.23	529.	6645.	9.50
0.50	1750.48	0.08	646	3306.	1.50
0.40	1749.97	0.0	485	2640.	0.0
0.30	1748.92	0.0	453	1971.	0.0

12 of 12

APPENDIX E

REGIONAL GEOLOGY

BRADFORD CITY NO. 3 DAM
NDI NO. PA 00025, PennDER No. 42-10

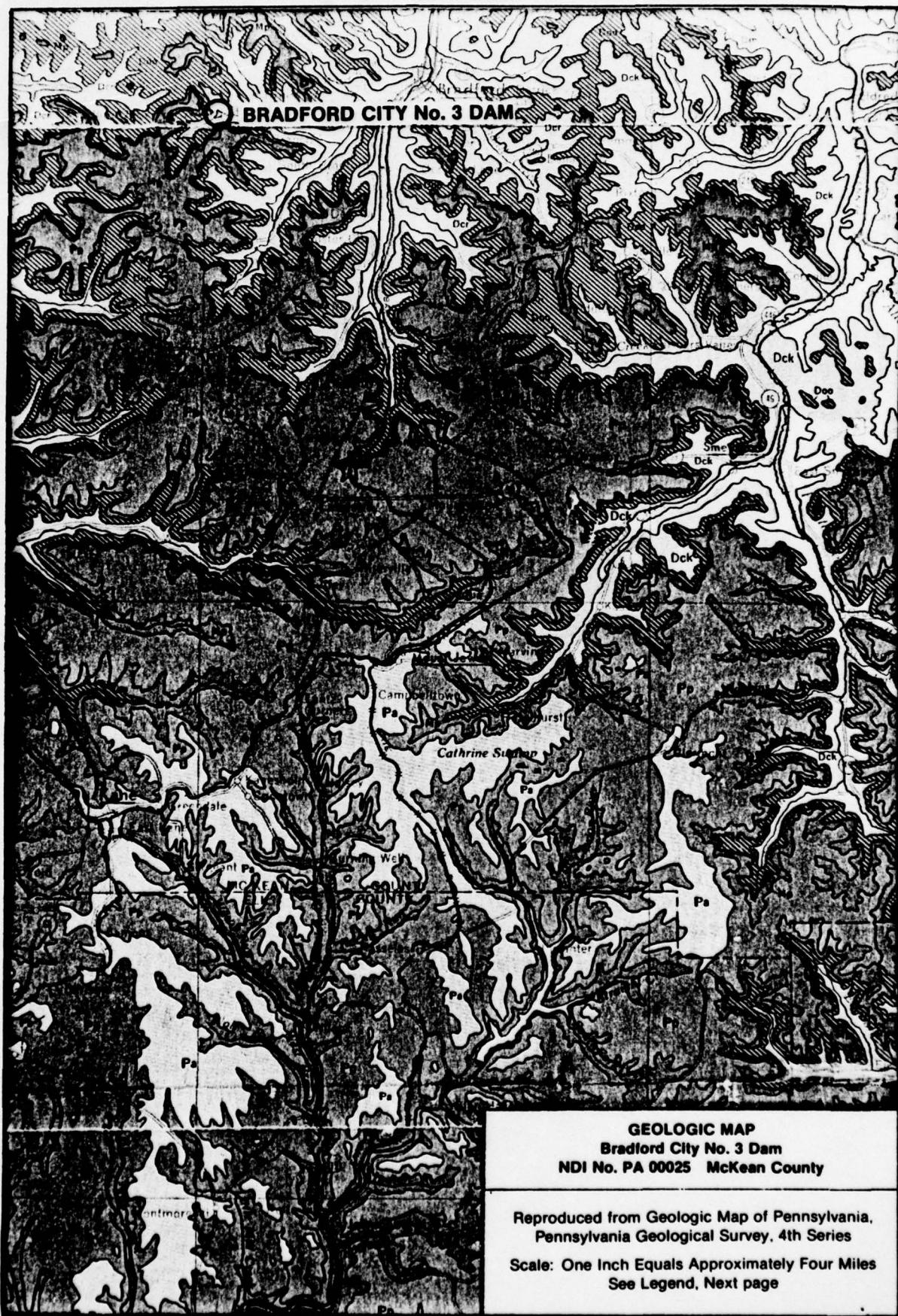
REGIONAL GEOLOGY

Bradford City No. 3 Dam is located in the unglaciated section of the northern portion of the Appalachian Plateaus physiographic province. Bedrock units are members of the Cattaraugus formation of the Upper Devonian system which are typically red, gray and brown sandstones and shales. These strata are essentially horizontal with gentle regional folding. References do not indicate any faulting in the vicinity of the dam.

Although the area has not been glaciated, the dam is located a short distance upstream from the relatively thick glacial stream and lake deposits which fill the valleys of Tunungwant (Tuna) Creek and its tributaries. However, it appears that most the dam and reservoir are located on residual soils of the Allegheny-Dekalb soil group which reportedly average about 4 feet in thickness. A small amount of alluvium may be present.

NEW YORK BORDER

BRADFORD CITY No. 3 DAM



LEGEND

PERMIAN

Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone and coal; base at the top of the Upper Washington Limestone.

PERMIAN AND PENNSYLVANIAN

Washington Formation

Cyclic sequences of sandstone, shale, limestone and coal; some red shale; some mineable coal; base at the top of the Waynesburg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU

Pa

Monongahela Formation

Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.

Pc

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coal; massive Mahoning Sandstone commonly present at base; Amherst Limestone present in middle of sections; Brush Creek Limestone in lower part of section.

Pa

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Venport Limestone in lower part of section; includes Freeport, Aspinwall, and Clarion Formations.

Pa

Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION

Pa

Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerates and numerous mineable coals.

Pa

Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Ma

Mauch Chunk Formation

Red shales with brown to greenish gray shaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Logatanna Limestone at the base in southwestern Pennsylvania.

Po

Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Conemaugh, Corry, and Knapp Formations; includes part of "Owasyo" of M. L. Fuller in Potter and Tioga counties.

DEVONIAN UPPER

WESTERN PENNSYLVANIA



Oswayo Formation

Greenish gray to gray shales, siltstones and sandstones becoming increasingly shaly westward; considered equivalent to type Onondaga, Riverville Formation Dr in Erie and Crawford Counties; probably not distinguishable north of Corry.



Cattaraugus Formation

Red, gray and brown shale and sandstone with the proportion of red decreasing westward; includes Venango sands of drillers and Salamanca sandstone and conglomerate; some limestone in Crawford and Erie counties.



Conneaut Group

Alternating gray, brown, greenish and purplish shales and siltstones; includes "pink rock" of drillers and "Chermung" and "Girard" Formations of northwest Pennsylvania.



Canadaway Formation

Alternating brown shales and sandstones; includes "Portage" Formation of northwestern Pennsylvania.